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ABSTRACT

Parents of children in the Saugus Union School District in California were concerned about the safety of classrooms, particularly portable classrooms. Their concerns were amplified by assertions of a local medical toxicologist following evaluations of some teachers and students, and by an Environmental Working Group report about alleged problems with portables throughout California. Efforts by the school district, environmental consultants, and Los Angeles County health authorities were not sufficiently reassuring to some parents. This report discusses results from an evaluation of the classrooms by the Environmental Health Investigations Branch (EHIB) of the California Department of Health Services. Findings indicated no elevated health risks to students. The report's first part details evaluation methods and findings, while the second part directly answers each of the questions posed to EHIB staff at a parent meeting. Data tables provide results of environmental sampling at each school. (Consultations with outside authorities are appended. Contains 68 references.) (EV)

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ED 463 644

ENVIRONMENTAL HEALTH CONSULTATION: REVIEW OF ENVIRONMENTAL AND CLINICAL LABORATORY INFORMATION

SAUGUS UNIFIED SCHOOL DISTRICT
AUGUST, 1999

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Prepared by
California Department of Health Services
Environmental Health Investigations Branch

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STATE OF CALIFORNIA-HEALTH AND HUMAN SERVICES AGENCY GRAY DAVIS, Governor

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August 6, 1999

Parents and guardians of children in Saugus Union School District

Dear Parents and Guardians:

We in the Environmental Health Investigations Branch of the California Department of Health Services have assessed the concerns about threats to children's health from inhabiting portable classrooms at Rio Vista, Helmers, and Foster elementary schools. The enclosed consultation benefits from many years of collective experience in the areas of clinical medicine, medical toxicology, environmental sampling, laboratory analysis, exposure assessment and health assessment.

The consultation is, in some ways, two related parts. One part is a general assessment of the issues. The second part is an effort to directly answer every question posed to us at a meeting with parents on the evening of July 22, 1999.

Please read this document before the community meeting on August 12 if at all possible. We have tried to describe the basis for every major statement in it. We ask you to review this document critically and challenge any material that contradicts your own beliefs and understandings. If you find things you disagree with, please bring to the meeting any material that will substantiate the need for correction. At the same time, we ask you to challenge your own assumptions and beliefs and try to determine the basis for them. Weigh carefully the information that is now before you.

Six repositories for non-circulating reference documents have been established at the Valencia Public Library and Rio Vista, Helmers, Foster, Bouquet Canyon and Sky Blue Mesa schools. These repositories have additional reports and information on toxics relevant to these concerns.

We hope you will find this document and the other materials at the information repositories educational and useful as you make your decisions about your children's attendance at school this fall.

Sincerely,

Richard Kreutzer

Richard Kreutzer, M.D., Chief
Environmental Health Investigations Branch

Enclosure

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EXECUTIVE SUMMARY

Parents of children in the Saugus Union School District (SUSD) are concerned about the safety of the classrooms, particularly portable classrooms. Their concerns have been amplified by assertions of a local medical toxicologist following evaluations of some teachers and students and by an Environmental Working Group report about alleged problems with portables throughout California. Efforts by the school district, environmental consultants and Los Angeles County Health authorities have not been sufficiently reassuring to some of the parents in the school district.

The Environmental Health Investigations Branch (EHIB) of the California Department of Health Services (DHS) was asked by the Los Angeles County Health Department and SUSD Administration to assist with evaluating the parents' concerns. After speaking with County health officials and meeting with school officials, the medical toxicologist and the parents on July 22, 1999, EHIB staff carried out the following activities and made these observations:

Review of construction and material specifications for portable classrooms

- Portables are designed to have appropriate ventilation capability.
- There was no evidence for arsenic exposure.

Inspections and review of classroom histories

- Rio Vista 25 and 40 vents found closed by consultants.
- Helmers #30 sited over a drain that clogged during El Nino, sited next to truck parking location with intake vents facing this location, put into use before being flushed of contaminants, put into use with malfunctioning air conditioning, door and windows frequently kept closed to conserve energy.

Review of environmental measurements

- Measurements are generally low or below the detection limit of the testing method. Arsenic and arsine – undetected.
- Formaldehyde levels are 18-26 ppb indoors and 5-6 ppb outdoors.
- Phenol and benzene levels are: Phenol – undetected, Benzene found at 0.5 – 0.6 ppb, both indoors and outdoors.
- The mold, *Stachybotrys chartarum* (a.k.a. atra) has never been detected.

Evaluation of clinical tests and results (These opinions are corroborated by many authorities, some of whom have provided written supporting statements that are included in the appendix.

- Tests of urinary formic arid are inappropriate to evaluate formaldehyde exposure. The results for students and teachers have been improperly interpreted as indicating formaldehyde exposure, as the presence of a risk to health, and as evidence of a problem with a classroom.
- Tests of urine/blood phenol are inappropriate to evaluate benzene exposure. The results for students and teachers have been improperly interpreted as indicating benzene exposure, as a risk to health, and as evidence of a problem with a classroom.

- Tests of blood arsenic are not appropriate means to monitor arsenic exposure.
- Tests of urine arsenic were modestly elevated for two people. These levels should be confirmed by repeat measurements. No school sources have been found.
- Tests of immunologic reactivity to *Stachybotrys chartarum* are inappropriate to evaluate current exposure. The results for students and teachers have been improperly interpreted as evidence of classroom exposure and as increased risk for disease.

Recommendations

- DHS should review biological testing results from sampling done August 4, 1999.
- Outside air intake vents of heating, ventilation and air conditioning (HVAC) units should be kept open.
- School officials should be familiar with DHS guidelines for portables.
- The school district should be recognized for adopting an environmental policy and for adopting U.S. Environmental Protection Agency (U.S. EPA) Indoor Air Quality (IAQ) Tools for Schools programs district-wide this year.
- Urine arsenic levels should be repeated for two students who had modest elevations in their first tests. If the values remain elevated, sources of arsenic exposure in the home, other locations, and in the diet should be explored.
- IAQ monitoring should occur for the first two weeks of school in Rio Vista #40 and Helmers #30.
- A parent oversight committee should be formed to oversee the above monitoring.
- The above parent oversight committee should be allowed to select up to 20 classrooms for targeted monitoring at any time during the school year.
- School district officials should make available to the parents the costs to the district associated with conducting this series of investigations.
- Conduct IAQ measurements on a new unoccupied portable classroom with ventilation off, comparable to existing models.

Conclusions

- Past exposure to volatile organic chemicals (VOCs) cannot be evaluated. Levels of VOCs may have been higher when the buildings were new and before the SUSD adopted their new environmental safety policy. There is no evidence that arsenic exposure from portable classrooms could have occurred.
- At the request of parents, DHS staff have framed their conclusion in personal terms. We would allow our children to attend school in any SUSD classroom if it is properly maintained and ventilated.
  We would feel especially comfortable if the school district honored its environmental policy and the IAQ Tools for Schools program by conducting regular inspections, maintaining the HVAC systems and providing continuous information and training to staff about indoor air quality issues.

INTRODUCTION

Parents of children in the Saugus Union School District (SUSD) are concerned about the safety of the classrooms, particularly portable classrooms. Their concerns have been amplified by assertions of a local medical toxicologist following evaluations of some teachers and students and by an Environmental Working Group report about alleged problems with portables throughout California. Efforts by the school district, environmental consultants and Los Angeles County Health authorities have not been sufficiently reassuring to some of the parents in the school district.

The Environmental Health Investigations Branch (EHIB) of the California Department of Health Services (DHS) was asked by the Los Angeles County Health Department and SUSD Administration to assist with evaluating the parents' concerns. After speaking with county health officials and meeting with school officials, the medical toxicologist and the parents on July 22, 1999, EHIB staff agreed to the following:

1. Request releases of medical information from teachers and parents of children in classrooms #30 Helmers and #40 Rio Vista and perform a review of the clinical basis for the statements about portable classroom safety;
2. Obtain all environmental data available prior to August 4, 1999 on classrooms performed by consultants to SUSD, evaluate the completeness and reliability of the data and determine what conclusions can be drawn about the environmental quality of the classrooms studied. Furthermore, determine if the information can be used to make statements about portables in general;
3. Obtain the consultant report on a school classroom attendance study and render an outside evaluation of this document (this task was not accomplished since the study is not completed);
4. Arrange to provide independent microbiological assessment of Helmers #30;
5. Try to obtain additional information about portable classroom safety in fires or earthquakes; and
6. Report back to parents and school administrators as quickly as possible given that the school year begins August 16, 1999.

This document is in two parts. The first part is organized according to the above activities and summarizes EHIB's findings. The second part directly answers each of the questions posed to EHIB staff by parents who attended the meeting on the evening of July 22.

BACKGROUND

This information is obtained primarily from SUSD records and from discussions with Los Angeles County health officials and parents. EHIB staff has not independently verified all information.

In February 1999, a local physician recommended that a student be removed from room 40 of Rio Vista School due to alleged exposure to formaldehyde. School administrators contacted the United States Environmental Protection Agency (U.S. EPA) and received a recommendation to conduct indoor air quality (IAQ) tests. Machado Environmental Corporation was retained to test rooms 25 and 40 (rooms where the child attended class) for contaminant gases, formaldehyde, microbial contaminants and dust. These test results were described as "normal".

Throughout March, other Rio Vista students and a teacher were clinically evaluated by a local medical toxicologist. During Spring Break in April, the medical toxicologist stated that the teacher of room 40 had tested positive for formaldehyde, phenol, arsenic and *Stachybotrys*. It was decided that the teacher and students should be moved to another classroom until additional testing could be performed.

At the end of April, Machado Environmental Corporation conducted IAQ tests of rooms 25, 26, 30, 31, 32, 40, and 41 for contaminant gases, formaldehyde and microbial contamination while Austin & Kalen Environmental Consultants measured arsine, arsenic and phenol in the same rooms. The Machado Environmental Corporation test results are described in May as "not detectable". Austin and Kalen results were reported later as "non-detects".

On May 6, Los Angeles County Health Department staff and environmental consultants met with parents to discuss the situation at Rio Vista and Helmers schools. They challenged the clinical basis for the concerns about the portables and indicated that they thought the portables were safe for students. Parents were not satisfied with these opinions and demanded more attention to the concerns. Later in May SUSD staff attended a U.S. EPA Indoor Air Quality Tools for Schools conference. An IAQ Tools for Schools committee was formed for Rio Vista School which was designated a pilot school for implementation of the program. The committee was composed of school administrators, teachers, parents and outside technical consultants, and met for the first time on May 25.

In June, a teacher from Helmers Elementary School room 30 reported that she had tested positive for *Stachybotrys chartarum*. At her request the students were moved to another portable classroom. Machado Environmental Corporation performed testing for *Stachybotrys* in room 30 the next day. Four days later, more testing was conducted in the sub-floor area and a visual inspection of the classroom uncovered no evidence of the mold. Subsequently, negative test results for *Stachybotrys* were reported.

Additionally in June, the SUSD Board unanimously approved a new environmental safety policy and formally adopted the IAQ Tools for Schools program to be implemented district-wide. The Saugus Teachers Association supported these positions. The second Rio Vista School IAQ Tools for Schools meeting was held on June 15.

SUSD administrators, the Los Angeles County Health Department and U.S. EPA contacted EHIB late in June. As parent concerns continued to escalate and additional students and teachers were being assessed by the local medical toxicologist as exposed to toxic substances, EHIB staff came to Saugus to meet with school officials, the physician and parents on July 22, 1999.

RELOCATABLE CLASSROOMS

Virtually all buildings, permanent and portable, use building and furnishing materials that can emit chemicals such as formaldehyde, solvents, etc. (Cooke 1991, Daisey 1993, Alevantis 1996, Hoskins 1993, Levin 1989, Molhave 1982, Molhave 1986, Tichenor 1988, U.S. EPA 1995). Unfortunately, there is relatively little air monitoring data specific to relocatable classrooms. The use of common construction materials suggests that the types of chemicals present in indoor air in relocatable classrooms are not different from those in other structures. For example, pressed-wood products are used extensively in both conventional and relocatable buildings, but are in relatively more dense use in the smaller space of the relocatable buildings. Pressed-wood products are a major source of formaldehyde. Typical formaldehyde levels in conventional California homes were measured at about 50 ppb[1] and in mobile homes about 70 to 80 ppb in the late '80s (ARB 1991). Levels of airborne chemicals may be higher in relocatable classrooms, and energy-efficient buildings in general, when ventilation is reduced. The U.S. EPA fact sheet on portable classrooms notes that providing proper ventilation can greatly reduce the concentration of indoor air pollutants in classrooms and is required by law (U.S. EPA 1999). DHS recommends that school districts follow the DHS Advisory on Relocatable and Renovated Classrooms to minimize potential exposures to indoor air contaminants in portable classrooms (DHS 1996).

The DHS "Advisory on Relocatable and Renovated Classrooms" was provided to advise school facility managers on how to minimize potential health impacts from indoor air quality problems in relocatable classrooms. The advisory notes that the California Department of General Services (DGS) bid specifications for relocatable classrooms require ventilation of a minimum of 480 cubic feet per minute of total outdoor air, limiting occupancy to no more than 32 persons. Outdoor air must be supplied continuously when a classroom is occupied. A replaceable filter is required in the ventilation system with a minimum 25 to 30 percent dust spot efficiency. The advisory notes that hard floors are preferable to carpet. However, the DGS program requires that units be carpeted except in certain areas such as bathrooms. The advisory recommends the manufacturer install carpet certified under the Carpet and Rug Institute's Indoor Air Quality Labeling Program. This is a voluntary program in which a sample of new carpet is collected at manufacture and then tested by the American Society for Testing and Materials. If the sample produces levels of total volatile organic compounds (TVOCs), styrene, formaldehyde, and 4-phenylcyclohexane (the chemical responsible for "new carpet" odor), that are below specified limits, it can qualify as a low emission carpet (Alevantis 1996). Other important issues include: siting classrooms away from locations where water accumulates after rains or vehicles idle; ensuring that at least one supply air outlet and return air inlet are located in each enclosed area; ensuring that building air intakes are located away from exhaust outlets; providing operable windows; and specifying building materials and room furnishings that are certified as "low emitting" for volatile organic compounds (VOCs). "Flushing out" (operating ventilation systems at their maximum outdoor air intake rate) of the new buildings prior to use for one to two weeks

[1] Reporting units for chemicals in air vary depending on the reporting laboratory and evaluating agency. Units that are commonly used are "parts per million" parts of air (ppm), "parts per billion" parts of air (ppb), and micrograms per cubic meter of air (mcg/m^3 or µg/m^3). Ppm and ppb values can be converted as follows: 1,000 ppb = 1 ppm. Conversion from micrograms per cubic meter to ppb or ppm requires a more complex mathematical calculation using the molecular weight of the chemical. This consultation summarizes most laboratory data in ppb and mcg/m^3 (see Tables 1 & 2).

is recommended. Regular maintenance is emphasized, including ventilation system inspection and replacement of water damaged materials.

DGS specifications establish the general requirements for a relocatable classroom. Relocatable classrooms obtained directly from manufacturers, i.e., school-district owned, may vary from DGS specifications, but have designs that are reviewed and approved by the State. The following are excerpts from the DGS bid specification, and serve to describe the general construction of a relocatable classroom with a wood frame (OPSC 1998).

Two-module classroom buildings consist of two 12' by 40' modules. All wood foundation materials below the sub floor are foundation grade redwood or pressure treated Douglas fir. Concrete or concrete block foundations are not allowed. Installation of the building is allowed for either soil, concrete or asphalt concrete paving, with suitable design-bearing capacity. The building must be securely fastened to the foundation. The roof, both joists and blocking, are Douglas fir / larch with a plywood sheathing. The wall components are also Douglas fir / larch, with plywood sheathing also used in the headers. Floor components, including joists, rim joists, and blocking, are pressure treated Douglas fir / larch with a plywood sheathing / sub floor. All plywood sheathing is exposure 1 grade. All weather-exposed surfaces have a weather-resistant moisture barrier to protect the interior wall covering. The moisture barrier protection is equal to the standard for kraft waterproof building paper or the standard for asphalt-saturated felt rag. Exterior siding is exterior-type plywood/siding. The roofing system is fire retardant, composed of either pre-finished 26 gauge sheet metal over felt underlayment and plywood deck, or 22 gauge steel interlocking panels. Exterior doors are steel with insulated polyurethane cores. All exterior doors are weather-stripped. All interior classroom walls are fire-retardant vinyl-covered insulation tackboard (asphalt-free) applied over sheetrock or plywood sheathing. A fire-alarm conduit and fire extinguisher are provided. Acoustical ceiling panels are mineral fiberboard or vinyl-faced fiberglass panels. Lighting is fluorescent. Exterior wood is painted with flat latex paint. Interior trim is semi-gloss latex over primer. Metal surfaces are painted with finish coats over rust inhibiting primer. Heating, ventilating, and air conditioning systems (HVAC) must meet American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE) Standards. Specifically, the mechanical ventilation system must provide a minimum of 15 cubic feet of outside air per minute (cfm) per pupil.

Portable classroom 40 at Rio Vista School is a district-owned portable, manufactured by Aurora Modular Industries. The design is approved by the State, and general specifications and construction materials are largely similar to those for state-owned portables. The Aurora portable uses fir of a lower grade in some of the framing than specified by DGS. The buildings are securely fastened to the foundation using state-approved methods. Moisture barriers are identical. Pressure-treated wood (arsenic treated) beams are only used in the foundation and are not accessible. The Aurora portable uses a built-up roof design, rather than the DGS-specific metal roof; this option was selected by the school district to reduce rain noise. The DGS specifications require a carbon dioxide sensor that opens the ventilation damper when CO_2 builds up; the Aurora portable does not have this feature. The DGS portable design uses a 5-ton air conditioning (AC) system; the Aurora portable has a 3-½ ton AC system. The Aurora ventilation system does provide the ASHRAE minimum of 15 cfm of outside air per person. Diagrams of

the Aurora portable classroom are included in the information repositories at the five SUSD schools and the public library.

Helmers #30 is an example of the kinds of problems with portables that should be avoided. Information about Helmers #30 was provided by the teacher and school administrators. This portable was newly opened in August, 1997. In fact, the carpet had been glued down just hours before the teacher entered to prepare the classroom for students to arrive a few days later. The electrical system was not hooked up and she performed her work in the August heat without much ventilation. By the time students arrived, the electrical system was engaged. However, the air conditioning system was malfunctioning. It was determined that a replacement part was needed and this took many days to arrive. Thus, the teacher and students were in the classroom for some time before it was properly functional. The teacher describes using the air conditioner only when it was very hot and uncomfortable in an effort to conserve energy. Often, if it was comfortable, doors and windows would be kept shut with no mechanical ventilation.

The portable had been placed over a low area of the asphalt where there was a drain. No problems were noted until El Nino storms brought more than usual rainfall and the drain plugged. Rather than disrupt class and cut through the floor to approach the plugged drain, sandbags were applied around the portable to keep the water out. At its maximum height, two layers of sandbags were not enough to keep water back. No water ever reached the actual floor level.

Since Helmers #30 is close to the school kitchen, delivery trucks for the food service and milk service pull up next to it and idle. The intake for the HVAC faces this parking area and allows for exhaust to be easily transported into the classroom.

These are the kinds of events that can, and should, be avoided. They represent the vast majority of problems with classrooms across the state: poor HVAC function, teachers and staff untrained on IAQ and ventilation issues, unnecessary encroachment of water, and siting next to a parking/loading area with unwanted exhaust.

Specific comments on concentrations of chemicals measured at the Saugus Union School District

The laboratory findings available to date for chemical monitoring are summarized below. The documents reviewed include: 1) an "Indoor Air Quality Investigation Report" by the Machado Environmental Corp., dated March 17, 1999; 2) an "Indoor Air Quality Investigation Interim Report," also by the Machado Environmental Corp., dated May 12, 1999; and 3) a compilation of chemical analysis test results for Helmers classroom 30, Rio Vista classroom 40, and Foster classroom 30 which was sent under cover memo from Environmental and Health Management Inc. on August 2, 1999. The first two reports are of investigations conducted only at the Rio Vista School. Specific chemicals for which health concerns were raised include arsenic (and arsine), benzene, carbon monoxide, formaldehyde, and phenol. The environmental monitoring results for these are summarized below. Monitoring data were also collected for a wide range of common chemical air contaminants (August 2 report). These data are summarized in Tables 1 and 2 of this consultation, and below under the heading "total VOCs."

Data Summary

Airborne arsenic - not detected in any samples at Rio Vista (inside seven rooms), with a detection limit of 2.77 micrograms per cubic meter air (mcg/m^3) (5/12 report). Not detected in indoor or outdoor air at Rio Vista #40 and Foster #30, with a detection limit of 0.05 micrograms per cubic meter. Not detected in Helmers #30 in indoor or outdoor air, with a detection limit of 0.1 micrograms per cubic meter (8/2 report).

Arsine gas - not detected in any samples at Rio Vista (inside seven rooms), with a detection limit of 0.069 micrograms per cubic meter air. Not tested for elsewhere.

Benzene – identified in both indoor and outdoor air at Rio Vista #40, Helmers #30, and Foster #30. Levels ranged from 0.5 to 0.6 ppb (parts per billion) both indoors and outdoors (see Table 2).

Carbon monoxide – detected in all samples in seven rooms at Rio Vista, at 1 to 2 ppm (parts per million), and found at similar levels of 1 to 2 ppm in outdoor air. Not tested for in other locations.

Formaldehyde – reported as sampled and detected in three rooms at Rio Vista (25, 40, and the school office) at 6 and 12 ppb (parts per billion) with the latter concentration reported for room 40 and the office. These levels are at or below the method detection limit of 10 ppb, with a ± 25% accuracy (3/17 report). Formaldehyde was later tested using a more sensitive method and found in indoor and outdoor air at Rio Vista #40, Helmers #30, and Foster #30, at levels ranging from 18 to 26 ppb indoors and 5 to 6 ppb outdoors (Table 2).

Phenol - not detected in any samples at Rio Vista (inside seven rooms), with a detection limit of 81 ppb (parts per billion). Phenol was not tested for in other locations.

Total VOCs – The results of testing for over forty specific volatile organic chemicals are in the report by Environmental and Health Management Inc. (8/2/99). The chemicals that were detected are summarized in Tables 1 and 2 of this consultation. Additionally, the laboratory found indications that other chemicals were present in air samples that could not be positively identified. This is a common occurrence in indoor air sampling, where a great variety of chemicals are typically found. These "tentatively identified" chemicals were identified based on a "best educated guess" by the laboratory and were assigned estimated air concentrations. Table 1 summarizes these findings as total VOCs (both positively and tentatively identified). The total VOC levels ranged from 343 mcg/m^3 indoors / 206 mcg/m^3 outdoors in Rio Vista #40, to 130 mcg/m^3 indoors / 146 mcg/m^3 outdoors in Foster #30.

Data interpretation

Arsenic was not found in air samples. Arsenic is not a typical indoor air contaminant. It may be present in low levels bound to dust particles in the air, but inorganic arsenic itself is not volatile. Arsenic is a soil constituent. Levels in soils average around 10 ppm (parts per million). US Geologic Survey soil samples in LA County and nearby counties were in this range (USGS 1981). Arsenic is sometimes found in drinking water. The federal Maximum Contaminant Level (MCL) for arsenic in drinking water is 0.05 ppm. Drinking water from the water companies who supply water to the Saugus school district contains arsenic ranging from undetectable to 0.005 ppm, well below the federal standard. Possible environmental exposures to arsenic include cigarette smoke, drinking water, casual soil ingestion, arsenic-containing pesticides and some fertilizers, arsenic-treated wood, and industrial activities, e.g., smelters. **Arsenic in arsenic-treated wood is not volatile**, i.e., does not release gas into the surrounding air. Treated wood used in the Rio Vista portable is in the foundation only and is not accessible without damaging the structure.

The California Office of Environmental Health Hazard Assessment (OEHHA) currently has a four-hour inhalation reference exposure level (an exposure level that is considered safe for the length of exposure) for arsenic of 0.19 mcg/m^3 (micrograms per cubic meter) for reproductive / developmental effects. OEHHA also has a proposed long-term (years of exposure) inhalation reference exposure level of 0.03 mcg/m^3 for developmental, cardiovascular, and nervous system effects. The more sensitive laboratory detection limits of 0.05 and 0.1 mcg/m^3 slightly exceed the long-term OEHHA level. Arsenic is a carcinogen. A theoretical exposure of a grade school-age child to arsenic at the detection limit of 0.1 mcg/m^3 would result in an increase in lifetime cancer risk (assuming exposure 8 hours per day, 180 days per year for 6 years), of 7 in-a-million. This is in addition to the U.S. lifetime population cancer risk from all causes of 333,000 in one million (one in three).

Arsine was not found in air samples. Arsine is not likely to be found in nonoccupational settings. Arsine is arsenic chemically bonded to hydrogen. The resultant compound is a gas. Arsine exposures are relatively rare, but do occur in some industrial settings. Arsine is used commercially by the electronics industry in the manufacture of semiconductors. Most cases of arsine exposure do not result from manufacture or use itself; instead they come from formation of arsine as a byproduct chemical reaction. For example, arsine may be generated in some metal smelting processes and in lead-acid battery manufacturing. OEHHA lists a 1-hour inhalation

reference level of 160 mcg/m^3 (micrograms per cubic meter) for hematological (blood) effects. OEHHA also has a proposed long-term (years of exposure) inhalation reference exposure level of 0.05 mcg/m^3 for cardiovascular system effects. The laboratory detection limit of 0.069 mcg/m^3 slightly exceeds the OEHHA proposed long-term exposure level.

Benzene levels were found in school air samples at 0.5 to 0.6 ppb (1.5 to 2 micrograms per cubic meter), both indoors and outdoors (Tables 1, 2). This is not an uncommon finding in urban areas (Pellizari 1986). Benzene (along with toluene, xylenes, and ethylbenzene) is a petroleum product. One of the most prevalent sources in the environment are motor vehicle emissions. A study of several California office buildings with a non-smoking policy estimated that most of the benzene in indoor air came from motor vehicle emissions (Daisey 1993). Local industrial activities may also contribute to the presence of these petroleum hydrocarbons in air. Levels of benzene and related air contaminants can vary based on the degree of contributing factors such as motor vehicle traffic, nearby industry, indoor cigarette smoke, use of products such as glues and paint, etc. Benzene may also be found in indoor air from use of adhesives, spot cleaners, some paints, paint removers, particleboard, and furniture waxes.

Carbon monoxide (CO) is a normal low-level constituent of air. Important environmental sources that increase CO levels in personal or outdoor air include cigarette smoke, combustion, and automobile exhaust. Concentrations exceeding 87 ppm (parts per million) have been measured in underground garages and tunnels. Eight-hour levels up to 10 to 17 ppm have been measured in outdoor air in the California South Coast Air Basin, which includes LA County. The California 8-hour air standard for carbon monoxide is 9 ppm. The measured levels of 1 to 2 ppm carbon monoxide in Rio Vista air samples are below this standard. Note: Carbon monoxide is also produced normally in the human body.

Formaldehyde was measured in indoor air at levels of 18 ppb (Rio Vista #40 and Helmers #30) and 26 ppb (Foster #30). Outdoor levels at these locations were 5 to 6 ppb (Table 2). Formaldehyde is a common indoor air contaminant, particularly in newer buildings. Common sources of formaldehyde include plywood, particleboard, ceiling panels, fiberboard, and some older types of insulation (urea-formaldehyde insulation, UFI). Formaldehyde is a component of some upholstery, carpet, wallpaper, cosmetics, and disinfectants. It is also a by-product of gas appliances and tobacco smoke. Formaldehyde is also a common constituent of photochemical (LA-type) smog. Studies in the late '80s showed that most homes had measurable levels of formaldehyde, averaging about 50 ppb in California homes (ARB 1991). To prevent irritant effects from exposure to formaldehyde (the most sensitive symptom of exposure), the California Air Resources Board recommends no more than 50 ppb (parts per billion) as an indoor air goal for homes (ARB 1991).

According to OEHHA, one hour of breathing air containing more than about 76 ppb formaldehyde can cause mild eye irritation. OEHHA also has a proposed long-term (years of exposure) inhalation reference level of approximately 2 ppb for eye and respiratory irritation. Both indoor and outdoor air concentrations exceed the proposed OEHHA long-term reference level. There is a safety factor of ten incorporated into this long-term reference, based on symptoms of irritation associated with occupational exposures averaging 15 to 180 ppb. Formaldehyde is classified as a probable human carcinogen based on evidence in animal studies.

Despite much research, evidence of human cancer from formaldehyde exposure is uncertain. A theoretical six-year exposure to a child at the highest level detected, 26 ppb of formaldehyde (similar to the calculation for arsenic) would have an associated lifetime cancer risk of four in-a-million. In sum, the formaldehyde levels measured in indoor classroom air are not different from those reported for most California homes, and are unlikely to cause adverse health effects in most individuals.

Phenol was not detected in air samples. Phenol is not a common constituent of building materials, but is found in a number of consumer products, including ointments, ear and nose drops, mouthwashes, analgesic rubs, antiseptic lotions, etc. Exposures may also occur through tobacco smoke, dietary intake, and automotive exhaust. OEHHA currently has a one-hour inhalation reference level for phenol of 5,800 micrograms per cubic meter (equal to 1,500 ppb), for mild eye and respiratory irritation. OEHHA also has a proposed long-term (years of exposure) inhalation reference level of 600 micrograms per cubic meter (equal to 160 ppb) for effects on the gastrointestinal, cardiovascular, and nervous systems, and the kidney. The laboratory detection limit of 81 ppb is below both OEHHA levels. Phenol is not believed to be a carcinogen.

Total VOCs – The range of levels of total volatile organic chemicals found in the most recent round of indoor air sampling are typical, both in types of chemicals and chemical concentrations, to that reported in the literature (Alevantis 1996, Levin 1989, Molhave 1982, Molhave 1986). The individual VOCs positively identified in indoor air have generally similar outdoor levels (Tables 1 & 2). Formaldehyde levels are higher indoors, as has been discussed. There is no difference between indoor and outdoor total VOC levels for Helmers #30 and Foster #30. The level of total VOCs is higher indoors at Rio Vista #40, 343 mcg/m^3 compared to 206 mcg/m^3 outdoors. It is unclear whether this is a consistent difference. Total VOC levels would need to be retested, perhaps several times, to make this determination.

California guidelines for total levels of volatile organic chemicals in indoor air have not been established. However, European guidelines and Washington state guidelines recommend comfort levels for total VOCs in the range of 200 to 500 mcg/m^3 (micrograms per cubic meter) of air for mucous membrane irritation. A multi-factored range up to 3,000 mcg/m^3 has been discussed in the literature, in which various factors, such as temperature, humidity and individual sensitivity, may come into play with respect to the occurrence of irritation (Alevantis 1996). The measured VOC levels fall within the suggested comfort range.

It should be pointed out that the VOC samples at Rio Vista #40, Helmers #30, and Foster #30 were collected with the ventilation systems in full operation. It cannot be known for certain, but levels of VOCs may well be higher in these rooms when the ventilation systems are off. Levels of VOCs may also vary with changing temperature and other environmental factors, e.g., increasing with increasing temperature in the rooms. Finally, it should be noted that these levels relate to current exposure conditions. Past exposures cannot be determined in these classrooms. However, the literature points out that it is the rule rather than the exception that VOCs tend to "offgas" or volatilize in higher concentrations from new building and furnishing materials, and that this process diminishes as a building ages. Using paint as an example, new paint has a distinct solvent odor that diminishes as the paint ages over days and weeks. There is no

indication that unusual indoor air chemicals, such as arsenic or arsine gas, have a source in these classrooms.

General comments regarding environmental chemical exposures

It is the rule rather than the exception that indoor air contamination is made up of many different chemicals from several chemical classes. A glance through the references at the local repositories will give you a sense of the numbers of chemicals commonly found in indoor air (Alevantis 196, Cooke 1991, Daisey 1993, Hoskins 1993, Levin 1989, Molhave 1982, Molhave 1986, Tichenor 1988, U.S. EPA 1995). Many of these chemicals have been found to be irritants, i.e., capable of causing symptoms of eye, skin, or upper respiratory tract irritation if present at high enough levels in the air. This is believed to be the earliest effect of exposure to these chemicals. The literature shows that formaldehyde and reduced ventilation are the most common indoor air complaints. In the SUSD classrooms, formaldehyde was found in several indoor air samples, and at lower levels in outdoor samples, but the concentrations measured are unlikely to cause discomfort or irritation. However, inadequate fresh air in classrooms may have been a problem, based on preliminary reports of low fresh air intake into some classrooms.

Levels of formaldehyde and other volatile chemicals common in newer buildings would be expected to drop in the indoor air of the building as emissions from furnishings and building construction materials age. Increased ventilation and elimination of some potential indoor VOC sources such as carpeting would be expected to further reduce or eliminate potential indoor air contaminants. However, should concern persist in this area, one approach to monitoring the levels of potentially irritating chemicals in indoor air is to measure them as a group and compare the total VOC levels to suggested indoor air guidelines (Alevantis 1996).

ENVIRONMENTAL ASSESSMENT - BIOLOGICAL

Specific comments regarding biological monitoring in SUSD schools

Results of visual inspection of classrooms by private consultants and environmental microbiological reports are summarized in this section. The documents reviewed include:

1. "Indoor Air Quality Investigation Report", Machado Environmental Corp., (report dated March 17, 1999) including results for Rio Vista rooms 40 & 25,

2. "Indoor Air Quality Investigation Interim Report", Machado Environmental Corp., (report dated May 12, 199) including results for Rio Vista rooms 25, 26, 30, 31, 32, 40 & 41,

3. "Report on inspection and testing of Room 30 at Helmers School", Machado Environmental Corp., (report dated July 8, 1999).

Rio Vista School

1. On February 18, 1999, room 40 was examined because the initial student who reported illness was assigned to this room. Room 25 was examined because this student was

moved into room 25 and reported a decrease in symptoms. Investigation of both rooms included a walk-through inspection, swab sampling of the ventilation equipment in each room and dust sampling for particle types.

During the walk-through, classroom interiors, ceilings, ventilation systems and surrounding outdoor environments were examined for visible signs of water damage, mold growth, and unusual stains or odors. A "new materials" odor was detected in room 40 and a "perfume" odor attributed to carpet deodorizer was reported in room 25. Outside air intake dampers for both classrooms were found fully closed.

Swab samples for direct microscopic examination of the air conditioning coils in rooms 40 and 25 showed some bacteria or small amounts of *Aureobasidium*, a common outdoor mold (Gravesen 1994). These findings are not unusual since cooling coils are frequently wet and dust can provide a nutrient source for the microorganisms.

Dust collected from both rooms was analyzed microscopically to determine the types of fibers and particles. Fungal spores or fragments of fungi made up less than 1% of the dust in both rooms. These results are consistent with those found in office buildings without mold contamination (Yang 1992).

2. On April 26-30, 1999, rooms 25, 26, 30, 31, 32, 40 and 41 were examined. These rooms were inspected because parents reported concerns about indoor air quality based on children's symptoms or learning that the two previous rooms may have had environmental problems.

A walk-through inspection was performed, followed by visual examination of each room's heating, ventilation and air-conditioning (HVAC) unit. Swab samples were taken from each room's cooling coils for detection of bacteria and fungi. Some ceiling tile and carpet water stains were noted in room 26. Dust samples from the stained carpet were also collected for microbial culture. Mild "volatile organic chemical-type" odors were reported in rooms when ventilation systems were off. Stronger "volatile organic chemical-type" odors were noted above the dropped ceilings where fiberglass insulation batts were located. No odors were detected in these rooms when the ventilation system was running.

Air conditioner coil swab samples were examined by direct microscopy. Findings varied from no microbial growth to mild or moderate levels of yeasts, bacteria or the common environmental fungi, *Alternaria* and *Cladosporium*.

Culture of dust from water-stained carpet in room 26 identified yeasts and bacteria dominated by Staphylococcus and gram-negative bacteria. These results indicate that the carpet area sampled had increased microbial growth. No *Stachybotrys* was found in these cultures after appropriate incubation.

Helmers School

3. On June 5, 1999, one day after students were removed from the classroom, a walk-through of room 30 was performed. The classroom interior, crawlspace, and area above the ceiling tiles was visually inspected. No mold was seen and no moldy odors detected.

   Air samples were collected using a spore trap device inside the room, in the crawlspace where flooding had previously occurred and outside the building (control sample). Highest level of total airborne fungal spores was found outside, the lowest level was inside the classroom, while the crawlspace showed levels between the other two sites. Fungi were identified to genus level (e.g., a genus is a group of related fungi) and there were fewer types found indoors than in either the outdoor control or the crawlspace samples. Dominant fungi were the same in all samples: *Cladosporium*, *Alternaria*, and basidiospores (spores from mushroom-type fungi). No *Stachybotrys* was found in these samples.

   The HVAC was disassembled, inspected and surfaces swab sampled for direct microscopic examination. This procedure found a few bacteria, no mold growth and no evidence of *Stachybotrys* spores.

   A sample of carpet dust was collected for culture. While there is only limited information available in the medical and environmental literature on expected microbial levels in carpet dust, the amount and types of fungi found on this sample were similar to those found in non-problem office and school buildings (Hodgson 1998a). Bacterial culture identified *Bacillus* and several other types of environmental bacteria.

   On June 9, 1999, additional visual inspection and sampling was performed in room 30 emphasizing the crawlspace and area above the ceiling tiles. Swab samples of the wooden foundation, the storm drain under the building and wooden construction debris in the crawlspace showed light to moderate growth of the common outdoor fungi *Cladosporium*, *Penicillium* and *Aspergillus*. Swab sampling of the interior surface of the wooden floor over the storm drain showed no fungal growth and only a few bacteria.

   Air samples collected by a spore trap device in the area above the ceiling tiles found few fungal spores of common outdoor fungi. An air sample was also collected inside the classroom while the carpet was beaten to encourage dust dispersion into the air (termed "aggressive sampling"). That sample showed much higher levels and a greater number of fungi types than the above-ceiling sample. However, no outdoor control sample was taken for comparison. No *Stachybotrys* spores were identified during aggressive sampling.

General comments regarding environmental microbiological exposure and testing

Bacteria, yeasts and fungi are everywhere in the natural environment. Samples of air, dust or any solid material will almost always show some of these organisms. Air samples may show extremely variable levels of microbes for several reasons. Many microbes grow and are released

into the air at irregular intervals, or depend on some form of air turbulence or material disturbance to make them airborne. Because there is a large variation in size, shape and mass of microbial particles, some remain airborne for extended periods, while others fall back to the ground rapidly. Outdoors as well as indoors, air temperature, humidity and wind speed or air movement can cause great variations in the levels of airborne bacteria and fungi from minute-to-minute or hour-to-hour. People also vary a great deal in their allergic sensitivity to these biological agents and their by-products. Because of these and other technical difficulties, it has not been possible for government regulatory agencies to definitively establish "normal" or "allowable" levels of bacteria or fungi in air, dust or carpeting. Thus there are no federal or state standards for fungal or bacterial levels in indoor non-industrial environments.

There are also no prescribed methods for collecting samples for microbiological analysis. While several professional organizations have recently published recommendations to assist in design of inspection plans, sampling protocols, decisions regarding use of measurement devices and data interpretation, following their advice is strictly voluntary (ACGIH 1999, Dillon 1996).

Molds - Mold spores primarily cause health problems when they enter the air and are inhaled in large number. People can also be exposed to mold through skin contact and by eating mold present in food. The amount of mold necessary to cause acute health problems varies greatly from person to person. Some people experience symptoms when exposed to only a small number of mold spores, while others experience no effects even in very moldy environments. Individuals who tend to have a higher risk for health problems from higher levels of mold spores include infants and children, the elderly, those with compromised immune systems, pregnant women and people with existing respiratory conditions (e.g., allergies, asthma).

Allergic or contact irritation reactions appear to be the most common health problems due to mold exposure. Typical symptoms that have been reported (alone or in any combination) include: nasal and sinus congestion, watery/reddened/burning eyes, light sensitivity, wheezing, shortness of breath, sore throat, cough, skin irritation and headaches. However, because these symptoms also occur due to numerous other conditions, it is very difficult, even for physicians, to positively determine their underlying cause.

Mycotoxins are chemicals produced as by-products of fungal metabolism. Not all molds are capable of producing toxins. Molds that have the ability to produce toxins are called toxigenic. Whether a toxigenic mold produces toxin in a given situation depends on several factors: environmental conditions such as moisture content and temperature, type of growth material, acid level (pH), and possibly the presence or absence of other organisms (Burge 1999a). The most frequently studied mycotoxins are produced by species of *Aspergillus*, *Fusarium*, *Penicillium*, and *Stachybotrys*. The natural function of mycotoxins has not been clearly established, but they are considered to play a role in regulating competition with other microorganisms. Mycotoxins can accumulate on mold spores, within the fungal body mass, or within the material on which the mold is growing. Mold toxins are not volatile and do not spread into the air as a gas or chemical. Spores are considered the most common vehicle for mycotoxin inhalation (Burge 1999a). Molds capable of producing toxins are found in all parts of the world and have been measured in stored grains, hay and straw (Olenchock 1990, Shen 1990).

In agricultural and food processing settings where workers are exposed to high levels of mixtures of molds, bacteria and other antigens, a flu-like illness (organic dust toxic syndrome) may occur. Symptoms include eye, nose and throat irritation, cough, fatigue and sometimes fever (Rylander 1994). Studies have linked long term occupational exposure to aflatoxin, a toxin produced by some, but not all, species of the mold *Aspergillus*, to increased risk for liver cancer. However, no causal relationship has been demonstrated between exposure to this mycotoxin from fungi growing indoors and symptoms of ill health in building occupants (Burge 1999).

Stachybotrys chartarum is a mold that may produce several different toxins, depending on the particular strain of the fungus, the material it is growing on, amount of moisture in its environment and other factors. For more information on this mold, please see the DHS fact sheet "*Stachybotrys chartarum*(atra): a mold that may be found in water-damaged homes" in reference materials repository sites. A series of case reports have suggested a relationship between *Stachybotrys chartarum* and building occupant illness, but a firm causal relationship has not been established. Investigation of an outbreak of lung hemorrhage among infants in heavily mold contaminated homes in Cleveland found *Stachybotrys chartarum* present but was not able to confirm that the mold caused the outbreak (Montaña 1997, Etzel 1998, Fung 1998). The actual role that *Stachybotrys chartarum* toxins play in human health problems from indoor inhalation exposure has not yet been clearly defined (Burge 1999b). While the most biologically active toxins produced by *Stachybotrys* (several macrocyclic trichothecenes) have been shown to produce immunosuppression and inflammation in laboratory animals, they have not been shown to be carcinogenic or mutagenic (Beasley 1989, IARC 1993). The trichothecenes are cleared very rapidly from the body, within a day or less and are not known to accumulate in body tissues (Jarvis 1999).

Bacteria - Evaluation of indoor samples for bacteria is controversial, as the health implications of inhalation exposure for many environmental bacteria are not well understood. There is no evidence that indoor exposure to most human-shed bacteria or environmental bacteria results in specific health risks (Dillon 1996).

CLINICAL LABORATORY EVALUATION

Many parents' concerns have been triggered by reports of children and teachers who have had tests done which reportedly indicate exposure to hazardous substances. Further it has been suggested that the source of these reported exposures is related to the portable classrooms. The purpose of this portion of our consultation is to review available clinical laboratory information and determine if the reports are indeed a valid indication of possible hazardous exposures and if there is adequate information to identify possible sources of any exposures.

Initially, DHS asked Dr. Gary Ordog and Dr. Rochelle Feldman to send medical records of patients they have seen with symptoms or concerns about health risks from the portable classrooms to DHS physicians for review. This request was denied based on concerns about patient confidentiality. A second request was then made for a summary of laboratory test results without individual patient identification. As of 8/4/99 this additional information has not been received. Letters were sent to all parents of children in Rio Vista classroom #40 and Helmers #30 which included a form authorizing children's medical records to be sent to DHS physicians. Additionally DHS staff brought medical records release authorization forms to the meeting on July 22, 1999 and distributed them to interested parents.

Through this process, some records on 19 children and teachers were received. Seven of these included only laboratory information, four included only history and physical information without laboratory results and eight included both clinical information and laboratory results. Where laboratory information only was received, an effort was made to contact the child's parents to determine if the tests were done because of the child's symptoms or due to parental concerns about possible exposures. Eight of the records reviewed were from children or teachers in Rio Vista #40, four were from children or teachers in Helmers #30 and seven were from children or teachers in other schools or classrooms. As DHS physicians could not access all desired records, it is difficult to completely characterize the reported symptoms and illnesses. However, some assessment of symptoms and clinical laboratory results can be made at this time.

Symptoms

Due to the need to address parental concerns prior to the opening of school on August 16, no attempt has been made to conduct a thorough assessment of reported symptoms in children in SUSD classrooms. Some children and teachers experienced symptoms that prompted testing, others had tests done because of concerns expressed by other parents and teachers. Some of the symptoms reported in the records and those mentioned at the public meeting on July 22, 1999 include headaches, stomachaches, recurrent sinus infections, ear infections, sore throats, fatigue, restless legs, and inability to concentrate. Many of these symptoms are common and have multiple possible causes.

General comments about clinical laboratory tests

Laboratory testing can sometimes be useful in assessing exposure to environmental contaminants when combined with information from clinical examinations and environmental assessments. Testing of children and teachers from SUSD was to aid in the diagnosis of medical conditions.

This is different from forensic testing which is done for legal purposes or experimental testing done for research purposes. Laboratories performing tests for medical diagnostic purposes must meet certain requirements of the Clinical Laboratory Improvement Amendments of 1988 (CLIA).

The results of any test must be carefully evaluated with respect to laboratory methods and the quality of laboratory procedures. Many of the tests that were performed on SUSD students and teachers are not part of typical medical evaluations. CLIA regulation of laboratories includes requirements for quality assurance, quality control practices and proficiency testing. Proficiency testing usually includes "spiked samples" and "blanks". Spiked samples have a known amount of a substance in them and blanks are specimens that contain none of the substance. These samples are usually provided by a Proficiency Testing Provider to assess the laboratory's accuracy. DHS staff are still gathering information about certification, accreditation, and proficiency testing of the laboratories that performed chemical tests on SUSD students and teachers.

Tests called "biomarkers of exposure" are done to determine if there is evidence someone has been exposed to a particular chemical. Some biomarkers directly measure the chemical in blood, urine, or other bodily fluids or components. Others measure metabolites (secondary chemicals produced by the body's processing of the chemical of concern) in blood or urine. In order to be useful in a clinical or research setting, a biomarker must be assessed for validity, sensitivity and specificity.

In choosing a biomarker for a particular exposure, it is important to understand how the body handles the chemical of concern. The manner in which it is absorbed, distributed, stored, and excreted as well as how long it resides in the body and how long it takes to eliminate it are important in deciding if a test is an appropriate biomarker. The half-life of a chemical is the time to eliminate half of an absorbed dose from the body. It is important to know the half-life of a chemical in order to choose the appropriate time for measuring a biomarker of exposure.

Validity is the extent to which a test measures what you think it is measuring. Validity is assessed by conducting experiments in which an animal or person is exposed to a known amount of a chemical and the biomarker is measured. Statistical methods are then used to determine how accurately the biomarker predicts the exposure or dose the subject was given. Some biomarkers are valid at one level of exposure but not others. Most biomarkers have been developed for use in industry to assure that workers are not exposed to harmful levels of chemicals. Factors that can affect the validity or usefulness of a biomarker include individual variation in the body's absorption, storage or elimination, exposures to similar chemicals, and effects from medications or diseases on metabolism.

Most biomarkers used in industrial settings have not been validated for use in assessing exposures to children. As children have differences from adults in how they absorb, metabolize and eliminate chemicals, tests validated in adults may not be valid in assessing children's exposures. Another important consideration is the appropriate reference range. A reference range is a range of levels that are expected in the general population of people not exposed to a particular chemical. As children's bodies may handle some chemicals differently, reference

ranges developed for adults may not apply to children. Reference ranges may also vary among children by age, race-ethnicity, nutritional status or other factors.

Sensitivity is the ability of a test to identify a substance when it is truly there. Tests that are not sufficiently sensitive may give a false impression that no exposure has occurred when it in fact has occurred. Specificity is a measure of how often a test indicates exposure to a chemical when exposure has not occurred to that specific chemical. Specificity is often a problem in tests that use metabolites of a chemical rather than the chemical itself. A metabolite is a chemical that results from the breakdown of the chemical of concern. Because many chemicals are metabolized in similar ways in the body, some tests using metabolites may reflect exposures not only to the chemical of concern but to other chemicals in the diet, medications or other environmental sources. A test that is not sufficiently specific may give a false impression that someone has been exposed to a particular chemical of concern when in fact they have been exposed to one or more other chemicals metabolized in a similar manner.

Specific comments in clinical laboratory tests

Formic Acid - Reports of elevated levels of urinary formic acid in some children have raised concerns about formaldehyde exposure to children in several SUSD classrooms. DHS physicians have reviewed four reports of urinary formic acid among district children. Test results ranged from 40 micrograms per milliliter (mcg/ml) to 91.3 mcg/ml.[2] These test results were reported as "high" based on a laboratory reference range of 21to26 mcg/ml. Because all four were from different classrooms, it is impossible to identify any patterns. Two children from Rio Vista #40 and one from another Rio Vista classroom had blood formate levels done. These results ranged rom 1.1 mcg/ml to 5.8 mcg/ml and were within the laboratory "normal" range. In a thorough review of the medical literature, DHS scientists have not found any reports supporting the use of these tests in reportedly exposed children or describing reference ranges of formic acid levels in unexposed children. Additionally, several studies have shown poor correlation of urinary formic acid levels with measured airborne levels of formaldehyde (Schmid 1994, Gottschling 1984, Boeniger 1987, ATSDR 1997b).

Animal studies indicate that after inhalation, approximately 40% of formaldehyde is exhaled. The formaldehyde that is absorbed into the blood is rapidly converted to formate and incorporated into other compounds in the body (ATSDR 1997b). Formaldehyde and formic acid are produced naturally in mammals by biochemical processes (WHO 1989, ATSDR 1997b). Formaldehyde is present in many foods, cosmetics and other consumer products such as dishwashing liquid, fabric softeners, nail hardeners and fabrics (ARB 1997, ATSDR 1997b, Bardana 1987, WHO 1989). Formaldehyde is found in the environment as a result of tobacco smoke, automobile emissions, gas and wood-burning stoves and fireplaces, and industrial sources (ATSDR 1997b, Bardana 1987, WHO 1989).

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[2] Chemicals in blood or urine are usually reported as the amount of the chemical in the amount of the specimen such as micrograms of formic acid in a milliliter of urine (mcg ml). Reporting varies depending on the lab and the method used. There are a thousand milligrams in one gram. There are a thousand micrograms in a milligram and a million micrograms in a gram. There are a thousand milliliters in a liter. Microgram is abbreviated as "mcg" or "µg". The abbreviation for liter is "L" and for a milliliter is "ml".

Urine formic acid testing is not specific for formaldehyde as other compounds such as methanol, halomethanes, acetone and common substances such as ascorbic acid (vitamin C) and aspartame (a sweetener used in soft drinks) are also metabolized into formic acid (d' Alessandro 1994, ATSDR 1997b). Formic acid measured in urine may reflect the combined formic acid naturally produced in the body and environmental and dietary exposure to formaldehyde. For these reasons, urinary formic acid measurement has been found to be unsuitable for use as a biomarker in worker exposure assessments (ATSDR 1997b, Clary 1992).

Although the reference range of the laboratory was listed as 21-26 mcg/ml, a variety of studies summarized by Yasugi (1992) have found levels in unexposed adults to vary widely with one study indicating levels up to 60 mcg/ml are within the normal range. DHS found no studies of formic acid levels in children's urine. Our analysis of the medical literature indicates that formic acid in urine does not correlate well with inhalation exposure to formaldehyde, is not specific to formaldehyde exposure, is not useful as a biomarker for industrial exposure to formaldehyde and has not been studied at all in children. Studies have shown that urinary formic acid levels vary more widely than the laboratory's reported reference range and there is no reference range available for children. Therefore, the urine formic acid levels measured in SUSD children may reflect a combination of endogenous, dietary and other environmental factors and do not provide accurate information about children's level of exposure to formaldehyde from classroom sources.

Phenol in urine or blood and benzene in blood - DHS physicians have reviewed reports of phenol or benzene tests performed in blood and urine among children at SUSD schools. Other children may have been tested but their results have not been received at the time of this consultation. There were seven reports of urinary phenol, one report of a blood phenol level and six reports of blood levels of benzene. Several different laboratories performed these tests. Urine phenol levels ranged from 2.1 to 100 mcg/ml. Five of these were within the laboratory reference range of <10 mcg/ml. Two were considered elevated by the laboratory at 17.9 and 100 mcg/ml. One blood phenol level and all blood benzene levels were negative (none detected). Local physicians, school officials and parents are concerned that the two urine phenol levels may indicate exposure to harmful levels of benzene from components of portable classrooms.

After inhalation exposure to benzene, approximately 30-50% is absorbed and the remainder is exhaled. In animals, steady state levels develop in blood, fat and bone marrow within 6 hours after continuous exposure and benzene is totally eliminated via exhaled air or urine within 15-40 hours after a short-term exposure. (WHO 1993, ATSDR 1997a) In one long-term study in dogs, all benzene was eliminated within 137 hours (within 6 days) after daily exposures of benzene for up to one year. (Schrenk 1941) After a steady state level is reached, benzene is eliminated from the body by exhaled air and by excretion of breakdown products, including phenol in the urine. Because of the short half life of benzene, laboratory measurements reflect only exposures which may have occurred within 1-2 days or at most 6 days after exposure stopped. Phenol that is inhaled or ingested is also eliminated from the body within 24 hours.

Measurements of benzene in blood and phenol in urine have been used to monitor benzene exposures in workplaces. The laboratory that reported the elevated level of urinary phenol indicated a "normal" range of < 10 mcg/ml. Baseline urine levels of phenol may vary widely and several studies have reported levels in unexposed populations of adults as high as 100-128

mcg/ml. (Roush 1977, Aitio 1994, Waritz 1995). For these reasons urinary phenol is no longer recommended for workplace biomonitoring (Aitio 1994, Waritz 1995, Boorgard 1996, Weisel 1996) No studies of phenol levels in unexposed children were found in a review of the medical literature.

Urinary phenol varies widely because it is not specific for benzene and is a breakdown product of many other compounds found in air, foods and consumer products. Phenol can also come from breakdown of normal components of protein and may be elevated in certain gastrointestinal conditions. (ATSDR 1997a, ATSDR 1997c, Duran 1973) Phenol containing products are common and include phenylsalicylate used as a coating for many medicines, mouthwashes, cold lozenges, skin ointments and shampoos (Waritz 1995). One study found urine phenol levels as high as 480-498 mcg/ml after ingestion of some medications and cold lozenges (Fishbeck 1975). In one industrial study, 5 out of 52 workers were found to have highly variable baseline levels (prior to workplace exposures) of urinary phenol ranging from 5 to 100 mcg/ml. (Roush 1977) Additionally, urine phenol levels may indicate benzene exposures from other common sources such as automobile exhaust, woodburning fireplaces or environmental tobacco smoke.

Arsenic - DHS reviewed six reports of arsenic measured in blood. Other individuals may have had this test run but results have not been received at the time this consultation was written. This test was performed at three different labs using different methodologies. Blood arsenic levels reported were all below the laboratory reference ranges. Arsenic is cleared from blood within a few hours and does not appear to be a reliable indicator of chronic exposure to low levels of arsenic (Valentine 1979, 1981). Therefore measurement of blood arsenic is not generally considered to be a reliable means of monitoring arsenic exposure (ATSDR 1998).

Arsenic is absorbed primarily from the lungs or gastrointestinal tract and is excreted in the urine, most of it within 1-2 days. For this reason, measurement of urinary arsenic levels is generally accepted as the most reliable indicator of recent arsenic exposure. Several different arsenic-containing chemicals can be measured in urine and these are usually divided into organic forms and inorganic forms. Organic forms of arsenic are non-toxic and come from eating seafood. Inorganic arsenic is the toxic form and its measurement in urine is useful for monitoring occupational or environmental exposures. There are no standards defined for urine arsenic levels in children. Occupational exposures that result in urine levels up to 50 micrograms inorganic arsenic/gram creatinine in adults have not been associated with any adverse health effects (ACGIH 1991).

There were six individuals with urine inorganic arsenic measurements ranging from 6-40 micrograms/gram creatinine. Two of these results were reported as high by one lab since they exceeded 25 micrograms/gram creatinine (mcg/g cr). Creatinine (a normal urine component) is used to adjust for differing urine concentrations. Inorganic urine arsenic levels in adults who have no occupational exposure can range from 0-50 mcg/g cr (Vahter 1986). The World Health Organization considers inorganic urine arsenic levels above 100 mcg/g cr to indicate an elevated exposure (WHO 1994). Physicians at the San Francisco Poison Control Center consider inorganic urine arsenic levels greater than 25 micrograms/liter as elevated, and those above 100 mcg/L (micrograms/liter) as potentially harmful (Kearney 1999, Williams 1999).

Upon review of portable classroom construction materials, the only component found to contain arsenic was treated lumber. Wood used in any type of foundation is commonly pressure-treated with preservatives containing a combination of arsenic, copper and chromium. In portable classrooms this lumber is used in the support of the foundations. The metals used in the preservation treatment are not released into the air. Therefore, arsenic exposure from attending class in a portable building is very unlikely.

Food and water are the major sources of arsenic for most Americans. In both groundwater and surface water the arsenic concentration is normally less than 10 mcg/L (micrograms/liter) (Pershagen 1986), but can exceed 100 micrograms/liter, especially from deep wells. Most foods contain low levels of arsenic. Fish and seafood consistently contain the highest concentration of arsenic. While most of the arsenic in fish and seafood is the non-toxic organic form (arsenobetaine), 5-10% is inorganic (Pershagen 1986). Persons who often eat fish or seafood can have 1.5 times higher levels of inorganic arsenic in their urine (Vahter 1986). Average arsenic levels in uncontaminated soils range from 0.2 to 40 ppm soil with the highest levels seen in the western U.S. Thus, elevations of urine inorganic arsenic may occur from numerous sources. As with many other diagnostic tests, if an elevated level is reported, the test should be repeated to determine if the result is consistent. Physicians at the San Francisco Poison Control Center recommend taking a 24-hour urine sample if elevated arsenic levels are suspected. If the urine inorganic arsenic level remains above 25 mcg/L, all potential sources of exposure from food, soil and water, both at the home and at the school or workplace should be investigated.

Fungal Testing - DHS received reports from five individuals who had blood samples taken for fungal serology (antibody testing). The same laboratory performed all the serological analyses. The methodologies used to perform these tests were developed and evaluated by this same laboratory. The U.S. Food and Drug Administration, the agency responsible for determining validity of medical testing procedures has not approved these serologic methods. Similar types of fungal serology tests have been shown to have limitations due to the ability of fungi to produce multiple antigens, to change their antigenic characteristics, and for several different types of fungi to share the same or similar antigens. The latter characteristic results in cross-reactions, where a person may be exposed, become sensitized and produce antibodies to one fungus, but the serological test indicates sensitivity to a different fungus. One of the primary limitations to understanding results from these tests is that there are no published data that indicate how many people in the general population (who have no unusual exposure) have antibodies to these fungi.

Of the five records reviewed, three had elevations in one or more types of antibodies:

IgE – 1/5 patients tested showed a mildly elevated response to *Cladosporium*
1/4 patients tested showed a mildly elevated response to *Stachybotrys* (one patient was not tested for *Stachybotrys* antibodies).

IgG – 1/4 patients tested showed a mildly elevated response to *Stachybotrys* .
3/5 patients tested showed mild to moderate elevated serum antibodies to, *Micropolyspora faeni*, *Thermoactinomyces*, *Aspergillus fumigatus*, *Aureobasidium pullulans*, or *Penicillium notatum*

IgA – 1/4 patients tested showed slight elevation of this antibody to *Stachybotrys*.

If we assume that a serologic test accurately measures an elevated level of antibody (either IgE, IgA or IgG) to a particular fungus, then it indicates that the person has been exposed to that fungus and that the person is producing antibodies to the proteins formed by the fungus. Elevated levels of antibodies do not, by themselves, indicate the presence of disease. Neither do they indicate the location or severity of the fungal exposure or whether the individual was exposed to fungal toxins. In the case of *Stachybotrys* serology, the participating laboratory specifically states that elevated antibody levels are not proof of mycotoxin exposure (Halsey 1999). Information provided by the laboratory also indicates that due to individual variations, the decline of fungal antibody levels is not predictable and cannot be used to establish the date of last exposure. More importantly, all of the fungi included in these testing protocols are common outdoor organisms that everyone comes into contact with during routine activities like lawn mowing, gardening, playing outdoor sports, hiking and camping.

Several studies were recently published regarding office building investigations involving documented presence of large amounts of *Stachybotrys*. Occupants from the fungal contaminated buildings were compared to persons from buildings that had no history of water damage or mold growth. These studies found no differences in *Stachybotrys*-specific serologic tests (IgE and IgG) between the mold-exposed and control occupant groups (Johanning 1996, Hodgson 1998b). Therefore, increasing evidence in the medical literature suggests that currently available serologic tests are not useful to determine the amount of mold exposure.

CONCLUSIONS

Past exposure to volatile organic chemicals (VOCs) cannot be evaluated. Levels of VOCs may have been higher when the buildings were new and before the SUSD adopted their new environmental policy. More recent measurements of total VOCs are within suggested comfort ranges. Formaldehyde levels were higher in indoor air than outdoor air but were consistent with levels found in other indoor environments and were within the ARB indoor air goal for homes. There is no evidence that arsenic exposure from portable classrooms could have occurred. The mold, *Stachybotrys chartarum* (a.k.a. atra) has never been detected in the classrooms evaluated. The environmental sampling conducted so far and reviewed by DHS was done by reputable firms using standard methods suitable for such investigations.

Clinical tests of urinary formic arid are inappropriate to evaluate formaldehyde exposure because the test does not correlate with formaldehyde exposure, lacks specificity, and has no reference range for children. Clinical tests of urine phenol are inappropriate to evaluate benzene exposure due to lack of specificity and absence of child reference ranges. Levels characterized as "high" based on laboratory reference ranges are within ranges reported for unexposed individuals in other published studies. The results for students and teachers have been improperly interpreted

as indicating formaldehyde and benzene exposure, as a risk to health, and as evidence of a problem with classrooms. Tests of blood arsenic are not appropriate means to monitor arsenic exposure. Tests of urine arsenic were modestly elevated for two people. These levels should be confirmed by repeat measurements. No school sources of arsenic exposure have been found. Tests of immunological reactivity to *Stachybotrys chartarum* are inappropriate to evaluate current exposure. The results for students and teachers have been improperly interpreted as evidence of classroom exposure and as increased risk for disease.

At the request of parents, DHS staff have framed their conclusion in personal terms. We would allow our children to attend school in any SUSD classroom if it is properly maintained and ventilated. We would feel especially comfortable if the school district honored its environmental policy and the IAQ Tools for Schools program by conducting regular inspections, maintaining the HVAC systems and providing continuous information and training to staff about indoor air quality issues.

RECOMMENDATIONS

- DHS should review biological testing results from sampling done August 4, 1999.
- Outside air intake vents of heating, ventilation and air conditioning (HVAC) units should be kept open.
- School officials should be familiar with DHS guidelines for portables.
- The school district should be recognized for adopting an environmental policy and for adopting U.S. Environmental Protection Agency (U.S. EPA) Indoor Air Quality (IAQ) Tools for Schools programs district-wide this year.
- Urine arsenic levels should be repeated for two students who had modest elevations in their first tests. If the values remain elevated, sources of arsenic exposure in the home, other locations, and in the diet should be explored.
- IAQ monitoring should occur for the first two weeks of school in Rio Vista #40 and Helmers #30.
- A parent oversight committee should be formed to oversee the above monitoring.
- The above parent oversight committee should be allowed to select up to 20 classrooms for targeted monitoring at any time during the school year.
- School district officials should make available to the parents the costs to the district associated with conducting this series of investigations.
- Conduct IAQ measurements on a new unoccupied portable classroom with ventilation off, comparable to existing models.

PARENT QUESTIONS

1. Do children have toxins such as arsenic in their blood?

   The appropriate test for arsenic exposure is the level in the urine, not blood. Thus far only two children from one family have had borderline elevated levels of inorganic urinary arsenic. If repeat tests show consistently elevated levels of arsenic, DHS physicians are available to assist in identifying any possible exposure sources for these children. There is no known source of exposure to arsenic from the portable classrooms. As discussed in the consultation, any arsenic used in treated wood would not be available for ingestion by children and arsenic does not get into the air unless the wood is burned or cut. Other tests have been performed which, according to some local physicians, indicate exposures to formaldehyde, benzene and toxins from *Stachybotrys* molds from some portable classrooms . DHS physicians and scientists disagree with that interpretation as the tests done are not reliable indicators of those exposures.

2. Should all children be tested for toxins and arsenic?

   No. Concerns about exposures to volatile chemicals from the portable classrooms are much better addressed by assuring proper ventilation and maintenance of the classrooms. Tests performed now would not indicate past exposures because some chemicals parents have raised concerns about (formaldehyde and benzene) are rapidly eliminated from the body. With information currently available to DHS, there is no source of exposure to arsenic in the classrooms. There is no evidence the portables were contaminated by *Stachybotrys* mold. Immunoglobulin testing for *Stachybotrys* only indicates exposure at some time to spores and may also cross-react with other molds.

3. What were children exposed to historically in Helmers #30?

   It is not known at this time if there were any chemical exposures historically in Helmers #30. Unusual chemical exposures would not be anticipated in a classroom setting. Low-level exposures may have occurred from volatile organic chemicals released from normal building and furnishing materials, or from use of classroom materials such as glue, magic markers, etc. Exhaust from vehicles idling outside the classroom and VOCs from the drain below the classroom could have entered the classroom in the past.

4. How much exposure to arsenic and VOC's is currently in Helmers #30?

   Helmers #30 has been tested for arsenic and VOCs. No arsenic was detected. VOC levels are within a normal range, and for most VOCs, are equal to the outdoor levels. Formaldehyde is higher indoors (18 ppb) versus outdoors (6 ppb) but still below the ARB guideline of 50 ppb.

5. Is the environmental testing that has been done adequate?

Yes. The sampling conducted so far was done by reputable firms using standard methods suitable for such investigations. Environmental monitoring was conducted at the Rio Vista School on February 18, 1990 and during the last week of April 1999. Sampling on February 18 was limited to two portable classrooms (i.e., Rooms 40 and 25). During this sampling period concentrations of carbon monoxide (CO) and formaldehyde (HCHO) were measured as well as biological matter. In April, additional classrooms were sampled (i.e., Rooms 26, 30, 31, 32, and 41). In addition to the chemicals and biologicals measured on February 18, concentrations of arsenic, arsine, and phenol were measured. VOC and arsenic testing were done at Rio Vista #40, Helmers #30, and Foster #30 during June, 1999. The VOC testing included tests for over 40 chemicals, both indoors and outdoors.

The measurements appear to be adequate given the parents' concerns at the time. Biological sampling was appropriate as an initial screening technique and was focused on areas of potential bacterial or fungal growth. With the exception of carbon dioxide (CO_2) the contaminants measured were selected based on assertions from the parents and Dr. Ordog. Although we understand that ventilation measurements were taken at these classrooms at other times, it would have been appropriate to measure concentrations of CO_2 during the two sampling periods. Although CO_2 is not by itself a contaminant, it can be used as a surrogate measure of ventilation.

6. How do we know that all portable classrooms are safe if each is not tested?

Things that could make a portable classroom unsafe include use of toxic building materials, bringing toxic materials into the room, siting the classroom close to sources of toxic material, allowing for persistent moisture or improperly venting the natural build-up of volatile gases that come from the human occupants or from other materials that may off-gas.

The materials used in the construction of portable classrooms are very commonly used in the construction of other structures like homes, office buildings and stationary classrooms. Much is known about their composition. In this document, we have included information about the State specifications on those materials. We have described the arrangement of those materials to make a portable classroom.

If we know the materials used and we visually inspect for undesirable objects brought into the classroom, sources of unwanted exposure near the classroom, evidence of moisture and proper functioning of the heating/air conditioning/ventilation (HVAC) system, then there is little reason for expensive, sophisticated or unusual testing.

7. Will DHS bring together the medical data from all the students?

DHS has reviewed medical information from 19 children and teachers from SUSD. State law and medical ethics require that any agency wishing to review a person's medical records receive written authorization from that person. If a child's medical records are involved, written parental consent is necessary. DHS mailed authorization forms to all parents and teachers in classrooms 40 Rio Vista and 30 Helmers, a total of 48 individuals or families. Four letters were returned as non-deliverable.

8. Are parents legally liable if they allow their children to attend class in rooms that parents believe have environmental problems?

Many parties have responsibility for the well-being of school children. Who bears responsibility in a specific case will depend upon the facts of the individual case. DHS's role is to try to provide the best scientific information possible. We are unable to offer legal advice, nor should we.

9. Are portables more toxic than other classrooms?

Portables use building and furnishing materials similar to conventional buildings. There has been relatively less testing for volatile chemicals in portable buildings. However, the California Air Resources Board (ARB) has shown that one common indoor air contaminant, formaldehyde, can accumulate to higher levels in mobile homes, which are similar in construction to portable classrooms. This may be due to a combination of reduced ventilation and increased density of use of formaldehyde-containing building materials, e.g., plywood, in a smaller space. The accumulation of indoor air contaminants can be greatly reduced by proper ventilation. Portable classrooms are equipped with ventilation systems that can provide adequate ventilation and are required to do so by law. The California Department of Health Services' "Advisory on Relocatable and Renovated Classrooms," (DHS, 1996), lists key recommendations for prevention of indoor environmental quality problems in portables.

10. Why do we have portables if they are more dangerous than permanent classrooms?

The construction of both portable and permanent classrooms falls under the same regulations, namely the California Building Standards Code (Title 24 of the California Codes & Regulations). When built and operated properly, portable classrooms are not "more toxic" or "more dangerous" than permanent classrooms. With proper care, both types provide satisfactory service, while problems can occur for either, due to failures in design, construction, operation or, especially, maintenance.

The decision of a school to use portable classrooms involves many considerations, such as funds, time, space and state requirements. We recognize that the number of portable classrooms has increased dramatically and rapidly in the past several years. This is due principally to the recent Class Size Reduction programs and past restrictions on the construction of permanent classrooms. Although complaints appear to be widespread, we

do not know whether serious problems truly occur more frequently for portables. The most common factor affecting environmental health in any classroom is insufficient ventilation. Another common problem is inadequate moisture control. While there are indications that portables may be more prone to some problems than standard construction, there is no evidence that they pose a greater risk to students or staff. Greater vigilance may be required to ensure a portable building starts and remains a satisfactory classroom.

The continued use of portable classrooms must be evaluated in the context of classroom overcrowding and the costs of building standard classrooms to replace them. Local school officials need to be supported with resources, guidelines, and clear mandates about the best ways to keep their portable as well as standard classrooms "healthy."

11. What symptoms should parents be watching for?

Symptoms such as headaches, eye irritation, sore or dry throat, stuffy nose or congestion, unusual fatigue and dry or itchy skin have been reported in 10-20% of occupants surveyed in randomly selected buildings. Certainly, your child's physician should assess any unusual symptoms. Rather than focussing on symptoms, parents and teachers should work with school district officials to develop policies and practices that assure proper maintenance, ventilation and safety of all classrooms.

12. Will a parent think a child has the flu when symptoms may be due to an environmental cause?

"Flu" symptoms include sore throat, fatigue, headache, runny nose, chest congestion, and fever. These symptoms may also be caused by other viruses and by allergies. Exposure to irritant chemicals can also cause sore throats, irritated or runny noses, cough and headache. Children may experience several episodes of viral illness yearly that commonly begin as children are exposed to each other in classrooms. Recurrent symptoms that occur during the school week and resolve during weekends and vacations may be building related, but could also be due to anxiety or other exposures near the building. This kind of situation should trigger an assessment of the building for water intrusion or visible molds and appropriate ventilation procedures rather than blood or urine tests.

13. Should children be tested now or is it too late?

DHS physicians don't believe that testing of children is the appropriate way to determine exposures to potential hazards from portable classrooms. A preferred approach would be to measure levels in the classrooms and maintain proper hygiene and ventilation in all classrooms. The tests that were performed on some children were not specific for the contaminants of concern such as formaldehyde and benzene and may reflect exposures to these and other chemicals from a variety of sources including diet, common medications, environmental sources and normal body processes. Arsenic testing is not indicated because there is no pathway for exposure to arsenic from the classrooms. The half life of

formaldehyde and benzene is very short so testing now would only indicate recent, not past, exposures.

14. What would be the long term effects from elevated formaldehyde or arsenic in the blood?

The tests reviewed by DHS do not indicate elevated levels of formaldehyde in blood. Some children had levels of formic acid in urine that were higher than the laboratory reference range but they are within the range of results reported in some studies. These tests are very non-specific and don't provide much information about possible levels of exposure to formaldehyde. The main health effect of formaldehyde at low levels is as an irritant of the eyes, nose throat or respiratory tract. Formaldehyde exposure may cause some asthmatics to have an asthma attack and higher exposures may cause some people to develop asthma. Formaldehyde at high levels such as those seen in industry in the past may cause cancer of the nose. Numerous studies of pathologists, morticians and other workers exposed to lower levels of formaldehyde have not shown a consistent pattern of other cancers. Interpretation of these studies is controversial.

Arsenic is not appropriately measured in the blood. The way to assess exposure to arsenic is by measuring it in the urine. Urine arsenic testing can be difficult and the lab needs to use appropriate methods to separate out non-toxic forms of arsenic such as arsenobetaine (e.g. from fish) from the potentially toxic forms. Thus far, DHS physicians have seen only two children from one family with slightly high, borderline levels of inorganic arsenic. This was found on one test only and DHS is awaiting information about a repeat test. The report discusses the use of arsenic in the portables. Based on information available to DHS, there is no reason to believe there are exposures of children to arsenic from sources in the portable classrooms. Arsenic exposure may cause a variety of long term health effects including increased rates of skin, bladder and lung cancers.

15. Who hired DHS researchers?

No individual or group hired DHS staff to perform this consultation. As part of the California Department of Health Service's commitment to assist local health departments and school districts with health-related problems, researchers from DHS responded to requests for support from both Los Angeles County Health Department and SUSD. DHS staff operates independently from local government agencies and school administrations. Our activities are supported by taxpayers through the California General Fund.

16. What are normal levels of formic acid and phenol for children?

As discussed in the report, formic acid and phenol in urine have been assessed for use in monitoring workplace exposures to formaldehyde, benzene and phenol. They are currently not recommended for this purpose because they are not specific for the chemicals they were used to monitor. Normal body metabolism or exposures to foods, beverages, medications and other consumer products may cause elevated levels in urine.

DHS physicians found no reports of the use of these tests in children and no indication of "normal ranges" for children.

17. How can the school district report that all tests are negative when some analyses require long incubation times (specifically *Stachybotrys*)?

In laboratory culture, *Stachybotry* produces spores after four to five days of incubation. Spores are needed for accurate identification of fungi in samples analyzed by culture or direct examination under a microscope. DHS staff spoke with both laboratories that tested air, swab, or dust samples. These laboratories do not finalize their readings of culture samples until five to seven days of incubation. Therefore, were *Stachybotrys* present, it would have had sufficient time to grow and produce spores. Incubation times longer than seven to ten days are unlikely to provide additional information. That it was not found means that no culturable spores were in the samples analyzed.

18. Are schools exempt from Proposition 65? If so, why?

Schools are exempt from Proposition 65. The exemption is within the statute itself, which states that city, county, and district agencies of state and federal government are exempt.

19. Will DHS address "vulnerability areas" of portables (siting on lawns, getting watered by sprinklers, placed over storm drains, etc.)?

Siting issues are discussed in Question 20, below. Most problems that lead to poor indoor environmental quality are the same for both portable or permanent buildings. These problems include: moisture accumulation (e.g., indoor air humidity is too high), liquid water intrusion (roof or window leaks, flooding, plumbing leaks or spills), water vapor movement (lawn sprinklers hitting an exterior wall followed by sun drying moisture through the exterior coating), use of volatile chemicals inside the room or outdoors close to air intake vents and exhaust from nearby vehicles or other sources. Please see the "Advisory on Relocatable and Renovated Classrooms" in the appendix of this document for more information.

20. Can DHS provide opinions on appropriate siting of portables?

There are a number of sources for good siting guidance (the U.S. EPA Indoor Air Quality Tools for Schools, the State of Washington *IAQ Best Management Practices*, and DHS's Advisory, to name a few). When followed, these recommendations will prevent most siting-related problems. The issue here, however, is that the practice has been to put portables classrooms "wherever one can." This is in contrast to the siting for a new permanent building, which usually entails more thorough site planning, including landscaping, drainage, set backs, and so forth.

21. Will there be assistance in interpreting a technical DHS report?

Yes. DHS staff will remain available to anyone who requests assistance with interpreting information about these issues throughout the school year. An indoor air quality phone request line has been established in our Environmental Health Laboratory Branch. Please leave a message at (510) 540-2476 and we will try to respond within 48 hours.

22. Why are there no specific environmental standards for children?

All non-occupational reference levels contain an additional safety factor intended to protect sensitive sub populations such as children, elderly and ill individuals. Typically a safety factor of 10 is added onto the safe level identified in animal studies, to protect sensitive people (including children) in addition to a safety factor to account for uncertainty in generalizing from animal studies to humans. In some cases there are additional safety factors specific to children. The Food Quality Protection Act of the U.S. EPA identifies pesticides for which insufficient data are available on health effects in the young, and suggests additional safety factors to compensate for these data gaps.

23. Concern about children's learning disabilities- can't focus, sit still, etc. in both portable and permanent classrooms – could this be due to environmental contaminants?

There are wide variations in children's activity levels and ability to adapt to the school environment. Learning difficulties can be caused by many factors and should be evaluated by a professional trained in making such assessments. Many academic researchers are conducting studies to try to determine factors that may contribute to the development of learning disabilities including possible environmental factors.

Some parents raised concerns about children's legs twitching at bedtime. Some of the reported symptoms may be "myoclonic jerks" which are twitches that occur normally as people are falling asleep and are common in children. Caffeine ingestion from soft drinks may also contribute to restlessness at night. A pediatrician or child neurologist should evaluate more serious symptoms.

24. Are detection devices used by SUSD's consultants sensitive enough to identify levels of contaminants that will make children sick?

The sensitivity varied for the detection devices used to identify specific contaminants in air. Detection limits for each contaminant and corresponding health reference levels are discussed individually in the consultation in the environmental laboratory data section.

25. Why isn't SUSD or DHS doing a properly controlled study of children in portables?

While specific portable classrooms in other parts of the state have been shown to present health risks to students and teachers due to their placement, their lack of proper maintenance, or improper ventilation, these problems are easily corrected and are not

unique to portables. Since portables are generally made up of the same materials as other buildings, there is little evidence that they represent unique exposures to children that should be singled out for study. Any resources that would be spent on a one-time only large scale study of portables would be better spent on a continuous program of training children and teachers about indoor air quality issues and conducting regular inspections to assure proper building maintenance and HVAC functioning.

26. Has the water been tested in depth?

All municipal drinking water companies are required to meet federal standards for providing safe drinking water. Included in the standards are required tests for chemicals and biological contaminants. These tests must be performed several times a year. Contaminants in drinking water must be below the federal standards established for safe drinking water, called Maximum Contaminant Levels (MCLs). We have received test results for arsenic and benzene for drinking water supplied to the school district. The results show no detectable benzene, and arsenic at low levels, ten-fold below the MCL for arsenic.

27. Will this exposure kill my child?

No. The levels of volatile organic chemicals including benzene and formaldehyde found in the classrooms are not different from most other homes, schools and buildings in the state. There is no known source of exposure to arsenic from the portables and testing does not indicate significant exposures to *Stachybotrys* molds.

28. What about earthquake and fire safety issues? Portables are not secured to foundations, are too close together, have only 1 door and do not have sprinkler systems.

All school construction, portables and permanent classrooms alike, must adhere to the same standards for earthquake and fire safety. Under the Field Act (found in Title 24, Part 1), seismic design and construction requirements are mandated for all public school buildings. The Division of the State Architect of the Department of General Services has structural engineers and fire/life safety staff review submitted design and construction documents for all classroom types. Portable as well as standard classrooms are classified as Type 5: non-rated. The local fire marshal exercises additional oversight to fire safety. Because portables are single-story buildings with four walls, they are among the safer structures on school campuses, with respect to earthquakes. Likewise, evacuation from portables in the event of a fire is safer than for multi-story buildings.

29. Will our children have problems in 30 years as a result of these exposures?

See response to Q27 and the full report regarding cancer concerns. At the levels which could potentially develop in unventilated portable classrooms, there are unlikely to be any long term health effects from exposure to formaldehyde or benzene. Again there is no evidence of exposures of children at SUSD schools to arsenic or *Stachybotrys* mold.

30. What about peeling wallpaper and black mold growing on the wall of classroom 19 Helmers? Should it be tested?

Peeling wallpaper may be due to moisture accumulation, but may also be due to aging of the adhesive. When DHS researchers inspected this room, we observed the peeling wallpaper but did not find evidence of obvious mold growth. Discolored areas on walls may be caused by mold growth, but can also be due to aged adhesive materials or staining from other causes. One of the ways to determine if a discoloration is due to mold is to apply a drop of bleach to it. If the color disappears there is probably microbiological growth. In addition, a piece of clear plastic tape can be pressed against the suspected moldy area then lifted off and pressed onto a glass microscope slide. The slide is then sent to a laboratory specializing in environmental microbiology. A trained mycologist examines the slide and determines whether mold growth or spores are present. See DHS fact sheet "Mold in My Home: What Do I Do?" in the local repository for more details on methods for mold clean up. A hand-held device called a moisture meter (similar to the wall stud finder familiar to home remodelers) can be used to determine if there is moisture within the wall itself. If mold or moisture is found, then the cause of the moisture problem must be determined and corrected.

31. Will medical information released to DHS be shared with SUSD?

All information shared with DHS researchers, including medical records data, remains strictly confidential. Information containing individual identifiers (name, address, phone number) cannot be disclosed to anyone other than the DHS researchers involved in the project. If a litigation action is brought, DHS may be required to produce medical records if these are subpoenaed. Summaries of medical information are included in this document, but we have tried to ensure that all those who participated by allowing us to review their records are protected.

32. How can testing of environmental conditions be accurate when children are not in the room?

Children or other individuals do not need to be present in a room for testing of most environmental chemicals. The level of most chemicals released from building construction materials and furnishings will not be affected by the presence of individuals. Of course, if the intent is to test for chemicals released from normal materials used in classroom activities, such as glue, then this should be done during the course of the activity. Some chemicals, for example carbon dioxide, are released into the air by human metabolism. Carbon dioxide buildup is an indicator of poorly ventilated areas. Testing for carbon dioxide should be done in the presence of the normal number of individuals in a room.

33. SUSD contracted with two physicians to provide second opinions regarding children's' and teachers' health concerns. Are these physicians board-certified in toxicology?

Both Dr. Dahlgren and Dr. Harber are board certified in internal medicine. Dr. Harber is also board certified in pulmonary diseases and occupational medicine. Training for the occupational medicine specialty involves work in the fields of toxicology, biological testing for chemical exposure, and evaluation of environmental causes of health problems. Dr. Harber is Director of the Occupational and Environmental Medicine Program at UCLA and has held numerous leadership positions in the American College of Occupational-Environmental Medicine.

Dr. Dahlgren is also specialized in occupational medicine. He has published and lectured on workplace and environmental health. He lectures on occupational medicine at the UCLA School of Public Health. He is also the founder and vice-president of a toxicology laboratory in southern California.

Physicians with occupational and environmental medicine training and experience are usually qualified to help their patients determine if their health concerns are due to workplace or other environmental conditions.

34. Can children's activities in portable classrooms kick up dust levels that could be harmful?

In any classroom, the movement of students and teachers and air blowing in from open windows or doors may resuspend dust and other fine particles. Whether this is harmful depends on the composition of the dust and how much of it gets into the air. Keeping classrooms clean is the best way to avoid dust buildup and related problems. Uncluttered shelves and desks and bare floors are easier to keep clean than untidy classrooms and carpeted floors. Thus, keeping a classroom healthy requires good housekeeping and regular cleaning.

35. Can children generate chemical interactions between their bodies and chemicals in the classroom air?

Children do not generate chemical interactions between their bodies and chemicals in the air. The human body will, of course, metabolize and detoxify many foreign chemicals that it comes in contact with.

36. How do parents learn of the availability of the DHS consultation document?

DHS staff will send copies of the written consultation document to SUSD Office where they will be reproduced. The school district will announce the availability of the DHS

document on their web site: www.saugus.k12.ca.us/environ. Announcements will also be placed in local newspaper. Parents may pick up copies of the consultation at:

1. Bouquet Canyon Elementary School
   28110 N. Wellston Drive, Saugus, CA 91350
2. Foster Elementary School
   22500 Pamplico Drive, Saugus, CA 91350
3. Helmers Elementary School
   27300 Grandview Avenue, Valencia, CA 91355
4. Rio Vista Elementary School
   20417 Cedarcreek Street, Canyon Country, CA 91351
5. Skyblue Mesa Elementary School
   28040 Hardesty Street, Canyon Country, CA 91351
6. Saugus Union School District Office
   24930 Avenue Stanford, Santa Clarita, CA 91355
7. Valencia Public Library
   23743 W. Valencia Blvd., Valencia, CA 91355

37. Is there a connection between the chemicals and the mold found in these children and teachers?

There is little evidence to support that tests conducted on children have demonstrated widespread exposures to chemicals or mold. As we have described in this document, some of the tests (e.g. formic acid and phenol) are very non-specific and represent a measure of many chemicals coming both from inside the body and outside the body. Thus, their presence is not abnormal. Other tests (e.g. *Stachybotrys* and other molds) have not been proven to demonstrate mold in the body nor necessarily dangerous exposure. Everyone is exposed to molds during their lifetime because these natural organisms are everywhere.

38. Can *Stachybotrys* come from portables sited on wet grass?

This could happen when the two essential ingredients for *Stachybotrys* (or any other fungus) to grow are present: (1) a suitable source of food and (2) enough water. Molds are able to use many materials as food, for example, paper, wood, dead leaves and grass and even leather. In particular, *Stachybotrys* is known to grow well on paper-based materials. Classrooms will remain free of mold if they are kept sufficiently dry. This is true even though schools use lots of paper and other materials on which molds could grow. In addition, mold spores are all around us, primarily from fungi growing outdoors. We can demonstrate this by washing various surfaces with a wet Q-tip and rubbing the cotton swab on culture medium. A high number of microorganisms will grow, even from what appear to be very clean places. It would be impossible to function in a world free of materials on which molds can grow. What's important is keeping classrooms reasonably clean and definitely dry enough to prevent mold growth.

39. If you can't generalize testing results from a large group of portables in the literature to those at SUSD, how can you generalize results from #30 Helmers to all the other Helmer's portables?

Please refer to question 6. Any portable classroom has the potential to be unsafe for children. Determining if a portable is unsafe is best done through direct inspection. Sophisticated tests are not necessary. If one or two portables constructed of the same materials as the others are shown to have low or non-detectable levels of chemicals, there is no reason to believe that there is a problem with other similarly constructed portables as long as they are located away from other chemical sources, do not have unwanted chemicals stored in them, are properly maintained (no obvious moisture problems) and have well functioning HVAC systems.

40. Why not test all kids at the beginning of the school year, then do follow up testing some months later?

The tests that were done are not useful in assessing children's exposures to formaldehyde, benzene and other chemicals because they are not specific for those chemicals and they may reflect other sources of exposure as well as internal body processes. A better method of identifying potentially hazardous exposures to these chemicals would be to measure levels in the classrooms. There is no reason to do testing for arsenic because there is no evidence to suggest a source of exposure to arsenic. *Stachybotrys* testing is not useful in assessing exposure.

41. How do parents get help to decide if classrooms are safe by August 17?

We hope parents will find this consultation document and the public meeting to be held on August 12, 1999 helpful in making decisions about their children's school attendance. Additional reference materials used in the preparation of the consultation document will be made available at 6 sites around the SUSD to allow parents to read more about topics of concern to them. Non-circulating reference materials will be available for review at the school offices of Rio Vista, Helmers, Foster, Bouquet Canyon and Sky Blue Mesa schools and the Valencia Public Library at 23743 W. Valencia Blvd.

42. How do parents get the State to fund testing of kids?

As we have indicated in this document, tests for formic acid and phenol are of little value in evaluating a child's symptoms. These tests do not indicate any specific exposures, but instead reflect an accumulated level of chemicals produced in the body as well as different chemical exposures that are broken down in the body. This situation can be different for the occupational setting where these tests might be applied to workers who have known high level exposures to specific chemicals that would represent the largest proportion of these accumulated chemicals.

There are no readily available human measures for current *Stachybotrys* exposure. Those *Stachybotrys* tests reported in SUSD children have not been rigorously studied to rule out

cross reactivity to other fungi. These tests indicate exposures that could have occurred at any time in the past, and in any location. Everyone is exposed to mold. It is exposure to unusually large amounts of mold that should be avoided.

Testing for arsenic, lead and other metals should be based upon the presentation of the child and information obtained from more conventional medical tests.

43. Does DHS have enforcement authority over the school district?

Not directly. DHS has broad powers to do what is necessary to protect the public's health. However, the elected school board officials are responsible for maintaining healthy conditions in schools. SUSD officials have indicated willingness to follow DHS recommendations for maintaining healthier conditions in classrooms. The U.S. Environmental Protection Agency IAQ "Tools for Schools" program was developed to assist school districts in maintaining healthy school environments.

44. Will DHS do bulk (core) sampling and culture for *Stachybotrys* in room 30 Helmers?

Yes. On Wednesday, August 4, 1999, a DHS staff member, Dr. Waldman along with Dr. Ordog, Dr. Faeder, a private environmental consultant recommended by DHS, Helmers school personnel and several parents visually inspected room 30 Helmers and collected additional samples for microbiological analysis. Bulk or "core" samples were collected that were grown in culture media under conditions that are optimal for *Stachybotrys* identification. Other sampling methods that have been shown effective in identifying the presence of *Stachybotrys* were also used. Results from these tests are pending.

45. Will records from the school nurse's office be reviewed as well as student absence reports?

DHS researchers have been informed that Dr. Anderson, the epidemiologist hired to analyze student absence data will be including school nurse visits in her analysis. The examination of student absence reports is a separate study that does not involve DHS participation. It is our understanding that Dr. Anderson's report will be available soon.

46. Can DHS put this risk into perspective?

The levels of volatile organic chemicals including benzene and formaldehyde found in the classrooms are not different from most other homes, schools and buildings in the state. Benzene and formaldehyde are found everywhere in the environment from a variety of sources discussed in the document. Theoretical cancer risks are discussed in the document. There is a great deal of controversy about whether formaldehyde and benzene at levels commonly found in indoor and outdoor air contribute to increased cancer risk.

47. Will the final DHS consultation include range of normal for environmental testing plus the measured numbers in the portables?

The DHS consultation does include a summary of the environmental testing done to date, along with health reference levels to which the data can be compared.

48. Would you send your child to this school/portable classroom?

Yes. We would feel especially comfortable if the school district honored its environmental policy and IAQ Tools for Schools program by conducting regular inspections, maintaining the HVAC systems and providing continuous information and training to staff about indoor air quality issues.

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TABLES

Table 1

Environmental sampling at Rio Vista Rm. 40, Helmers Rm. 30, and Fosters Rm 30, July, 1999
(results in micrograms per cubic meter air)

VOC (positively identified)	**Rio Vista** (mcg/m3) Indoor	Outdoor	**Helmers** (mcg/m3) Indoor	Outdoor	**Foster** (mcg/m3) Indoor ->	<-duplicate	Outdoor
chloromethane	nd	1.2	nd	nd	nd	nd	nd
acetone	42	32	27	21	30	31	26
trichlorofluoromethane	1.8	1.8	1.7	1.7	1.7	1.8	1.8
methylene chloride	1.3	1.2	1.3	1.2	1.1	1.1	1.1
trichlorotrifluoroethane	nd	0.69 tr	nd	0.69 tr	0.70 tr	0.68 tr	nd
carbon disulfide	3.6	1.1	3.4	4	1	1	nd
methyl-t-butyl ether	6.5	5.8	6.3	6.1	4.8	4.9	4.9
2-butanone	5.3	4.3	14	3.6	2.9	3	3.6
chloroform	nd	0.86 tr	nd	nd	nd	nd	nd
benzene	2	1.8	1.7	1.8	1.5	1.5	1.5
carbon tetrachloride	0.76 tr	0.83 tr	nd	nd	0.72 tr	0.68 tr	nd
4-methyl-2-pentanone	nd	2.1	nd	nd	nd	nd	nd
toluene	8.6	6.8	7.6	5.4	2.8	2.5	4.7
2-hexanone	0.73 tr	nd	nd	nd	nd	nd	nd
tetrachloroethene	1.5	4.1	1.4	1.2	2.3	2.1	0.99 tr
ethylbenzene	1	0.99 tr	0.99 tr	0.88 tr	nd	nd	nd
m- & p-xylenes	2.9	2.8	2.9	2.5	nd	nd	1.9
styrene	0.79 tr	nd	nd	nd	nd	nd	nd
o-xylene	1.2	1.2	1.2	1	nd	nd	0.83 tr
formaldehyde	22	5.9	22	7.8	32	no dupl.	5.8
Sum of positively identified VOCs (above)	102	75	91	59	82	50	53
Sum of tentatively identified VOCs (footnote)	241	131	74	102	48	56	93
Sum of all VOCs	343	206	165	161	130	106	146
inorganic chemical: arsenic	nd	nd	nd	nd	nd	no dupl.	nd

(mcg/m3) - micrograms of chemical per cubic meter of air
VOC - volatile organic (carbon-containing) chemical
nd - not detected in sample
tr - reported as "trace" by the lab, meaning the stated level is below the limit of accurate quantitation
no dupl. - no duplicate sample taken
Footnote: There were a number of tentatively identified chemicals which varied for each sample location. The lab was unable to positively identify these, but provided a "best guess" and estimate of each chemical concentration. The sum of the estimated air concentrations is shown above. The chemicals tentatively identified, like the positively identified chemicals, are common air contaminants.

Table 2

Environmental sampling at Rio Vista Rm. 40, Helmers Rm. 30, and Fosters Rm 30, July, 1999
(results in parts per billion, ppb)

VOC	Rio Vista (ppb)		Helmers (ppb)		Foster (ppb)		
(positively identified)	Indoor	Outdoor	Indoor	Outdoor	Indoor ->	<-duplicate	Outdoor
chloromethane	nd	0.57	nd	nd	nd	nd	nd
acetone	18	14	11	8.8	13	13	11
trichlorofluoromethane	0.33	0.31	0.3	0.29	0.31	0.32	0.32
methylene chloride	0.38	0.33	0.37	0.35	0.31	0.32	0.32
trichlorotrifluoroethane	nd	0.09 tr	nd	0.09 tr	0.09 tr	0.09 tr	nd
carbon disulfide	1.2	0.35	1.1	1.3	0.33	0.33	nd
methyl-t-butyl ether	1.8	1.6	1.7	1.7	1.3	1.3	1.4
2-butanone	1.8	1.4	4.9	1.2	0.98	1	1.2
chloroform	nd	0.18 tr	nd	nd	nd	nd	nd
benzene	0.63	0.57	0.54	0.55	0.47	0.46	0.47
carbon tetrachloride	0.12 tr	0.13 tr	nd	nd	0.11 tr	0.11 tr	nd
4-methyl-2-pentanone	nd	0.52	nd	nd	nd	nd	nd
toluene	2.3	1.8	2	1.4	0.73	0.68	1.3
2-hexanone	0.18 tr	nd	nd	nd	nd	nd	nd
tetrachloroethene	0.22	0.6	0.2	0.18	0.33	0.31	0.15 tr
ethylbenzene	0.23	0.23 tr	0.23 tr	0.2 tr	nd	nd	nd
m- & p-xylenes	0.68	0.64	0.67	0.57	nd	nd	0.44
styrene	0.18 tr	nd	nd	nd	nd	nd	nd
o-xylene	0.28	0.27	0.29	0.24	nd	nd	0.19 tr
formaldehyde	18	4.8	18	6.3	26	no dupl.	4.8
inorganic chemical:							
arsenic	nd	nd	nd	nd	nd	no dupl.	nd

ppb - parts per billion parts of air; 1000 ppb equals 1 part per million, ppm
VOC - volatile organic (carbon-containing) chemical
nd - not detected in sample
tr - reported as "trace" by the lab, meaning the stated level is below the limit of accurate quantitation
no dupl. - no duplicate sample taken
Footnote: The laboratory reported tentatively identified VOCs only in units of micrograms per cubic meter, not parts per billion. Please see Table 1 for the sum of tentatively identified VOCs and the total VOC sum.

ADDENDUM 1

Consultations with Outside Authorities

- Michael Shannon, M.D., M.P.H.
  Director, The Pediatric Environmental Health Center
  Children's Hospital/Harvard Medical School, Boston, MA
  President, The American College of Medical Toxicology

- William O. Robertson, M.D.
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- Chin S. Yang, Ph.D.
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- Jeffrey Kishiyama, M.D.
  Director, Clinical Allergy and Immunology
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- Bruce Jarvis, Ph.D.
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- Harriet Burge, Ph.D.
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Consultations with outside authorities regarding environmental and clinical testing procedures at Saugus Unified School District (SUSD)

In addition to reviewing medical and environmental references for information regarding the concerns that have been brought up by local clinicians, teachers, and parents of children at SUSD schools, DHS staff contacted various individuals for information. Some of the individuals responded by electronic mail (email), others by phone and some sent letters. Attached are copies of the email and written responses received. Because the email responses contained some personal information, and because some were written in highly technical language, the responses have been summarized. The originals of the emails are available for inspection if needed. Below is an example of the summary sent to these outside experts and the questions they were asked.

The California Department of Health Services has been asked to provide consultation to concerned parents, school district officials and county health department personnel about possible environmental exposures from portable classrooms in southern California. Several local physicians, under the guidance of a medical toxicologist, have tested children for levels of formic acid, phenol, hippuric acid, 2,5,hexanedione in blood or urine and inorganic arsenic in urine, a battery of immunological parameters, and IgE, IgA and IgG antibodies to stachybotrys chartarum mold. Some of the children were tested because they complained of recurrent infections, upper respiratory symptoms, allergic symptoms or headaches that were noted during school hours but resolved over weekends and school vacations. Other children were tested because the parents had heard that other children in the classroom had toxic levels of chemicals found on testing. Additional parents who have not had their children tested are worried about allegations that their children may have been exposed to harmful chemicals. We would like your assistance in addressing the following questions about some of the testing that was done and the clinical approach to such problems.

1. What is the role of laboratory testing in assessing children with symptoms of recurrent headaches, sinus infections, or cough that parents attribute to possible exposures from portable classroom contaminants?
2. Is formic acid in blood or urine a validated biomarker for formaldehyde exposure in children?
3. Is there an established "normal range" for blood or urine formic acid levels in children?
4. How would you approach the assessment of a child reported to have a level of formic acid in urine of 91.3 mg/L (66.2 mg/g creatinine, lab reference range 21-26 mg/l)?

5. Is blood or urine phenol a validated biomarker for benzene exposure in children?
6. Is there an established reference range for urine or blood levels of phenol in children?
7. Does a result of 100 mcg/ml (lab reference is < 10 mcg/ml) in a child indicate an exposure to excess levels of benzene?
8. What other compounds can affect the results of a blood or urine phenol test?
9. What is a "normal range" for urinary inorganic arsenic in children?
10. Would you be concerned by a result of 40 mcg/g creatinine (52 ng/ml) for inorganic arsenic in urine?

11. What level of arsenic in urine would you consider potentially toxic? At what level would you recommend chelation therapy?

Immunology questions

1. What is the role of an immunologic evaluation in assessing a child with recurrent upper respiratory or sinus infections?
2. What is the usefulness of Interleukin-2 production test results in children? What is a "normal range" for interleukin-2 production in children? (the lab reference range is "3-5 U/Million Lymphocytes")
3. Do increased serologic levels of IgE, IgG or IgA to stachybotrys chartarum indicate high environmental exposure?
4. Does increased stachybotrys chartarum IgA level (compared with lab reference levels) accurately indicate recent exposure to stachybotrys chartarum?
5. Does increased stachybotrys chartarum IgG level accurately indicate past exposure to stachybotrys chartarum?
6. Does increased stachybotrys chartarum IgE level accurately indicate allergic reaction to stachybotrys chartarum?

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August 6, 1999

Dr. Rick Kreutzer
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Dear Dr. Kreutzer:

Enclosed are my responses to your inquiries. I will respond in the order asked rather than go through repeating each question.

1. There is a valuable role for laboratory testing of children with health complaints that parents attribute to possible exposures to classroom contaminants. However this should be strictly guided by the results of air quality assessments.

2. Formic acid is not a validated marker for formaldehyde exposure in either children or adults. It rises after formaldehyde ingestion but has not been proven to rise after formaldehyde inhalation.

3. The "normal range" for formic acid in children would be similar to that in adults. Consult the laboratory's reference range. One of my texts states that for blood the average is 4 mg/L and urine 15 mg/L. However, this is dependent on technique, which is why you must go by the lab's reference range.

4. There are several potential explanations for elevated formic acid in urine; formaldehyde inhalation is not one of them There would need to be a careful review of diet and medications. Remember that we all make formic acid it is an intermediate of folate metabolism and produced as a byproduct of aspartame ingestion (e.g., Diet Coke). A diet history is therefore key. There may also me the need to rule out a congenital metabolic disorder.

5. Urine phenol is a validated biomarker for benzene exposure in children. However, it is not diagnostic. In order to make the diagnosis of benzene exposure, in child or adult, one needs to review the environmental history in some detail as well as perform environmental analyses. It is important to remember that phenol is cleared from urine quickly. Therefore an elevated level means very recent exposure.

6. There are reference ranges for phenol in blood and urine. Here again the standards in unexposed adults are used

7. A urine phenol concentration of 100 mcg/ml suggest an exposure to benzene but certainly doesn't prove it. The level must be interpreted in conjunction with history and air analyses

8. There are many compounds which could produce elevated phenol in urine. Phenol is ubiquitous, found in medications, mouthwashes, soaps, douches, detergents and a host of other household products.

9. There is no established "normal range" for inorganic arsenic in children However, if your question is about the normal range of total urinary arsenic, it is 50-100 ug/L, depending on the prevalence of arsenic in the local geostructure. But, as you know, in order to distinguish inorganic from organic arsenic in urine, the specimen must be specked. A study of normal values of speciated urine in children has not, to my knowledge, been done. That's why there is no well-established normal range for this particular toxin.

10. Having said above that there are not a wealth of data on the normal range of inorganic arsenic levels in the urine of children I would not be concerned by a result of 40 mcg/g creatinine arsenic in a child because that is quite a low level. Parenthetically, an obvious first question in the interpretation of this result would be the question about sea products in that child's diet (since seafood, seaweed and other products from the ocean contain nontoxic, organic arsenicals)

11. I would consider, depending on circumstances and speciation, a urinary arsenic of 100 ug/L or greater as being potentially toxic. I would probably chelate a child with a level greater than 200, depending on etiology and presence of referable symptoms.

Immunology.

1. There is an important role for immunologic testing in the child with recurrent upper respiratory or sinus infection. Such testing is extremely valuable and I typically recommend it. These tests, though, are confined to the standard assessments performed by pediatric allergists/immunologists, namely immunoglobulins, tetanus antibody, candida skin tests and complement factors.

2. There is, to my knowledge, no established role for interleukin-2 activity in children with known or suspected environmental illnesses.

3. Increased levels of immunoglobulins to Stachybotrys suggest but do not prove high environmental exposure. This is an area in which there are still too few data.

4. An increased IgA does not accurately indicate recent exposure to SC.

5. I believe an increased IgG level to SC indicates a past exposure.

6. A believe that an increased IgE to SC suggests but does not accurately indicate an allergic reaction to SC (whatever that means). The toxicity of SC has not been placed in the "allergic", immune mediated spectrum of disorders as much as the "pulmonary", direct toxicity spectrum (although these obviously overlap).

I hope these opinions are helpful.

Sincerely,

Michael Shannon, MD, MPH
Director, The Pediatric Environmental Health Center
Children's Hospital/Harvard Medical School, Boston, MA
President, The American College of Medical Toxicology
Editor, Clinical Management of Poisoning and Drug Overdose
Haddad, Shannon & Winchester, Eds, Saunders, 3rd Edition, 1998

PS. Because I am doing this as a service to a state agency, I will not charge a fee for my literatur eeview and preparation of these responses.

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Certified Regional Center of
American Association of
Poison Control Centers

August 4, 1999

Debra Gilliss, MD
CA Dept of Health Services
1515 Clay Street Suite 1700
Oakland, CA 94162

Dear Dr. Gilliss:

Regarding the questions posed in the memo forwarded to us here at the Washington Poison Center on 29 July, our group of some five board-certified medical toxicologists who serve as Associate Medical Directors of our Washington Poison Center, devoted a good portion of our weekly "telephone conference" to the questions posed. The consensus derived is as follows:

1) At present, laboratory testing is somewhat of a last resort in assessing children with symptoms attributable to school environments; rather careful epidemiologic assessment and occasionally industrial hygiene testing would precede such individual assessment.

2) At present, formic acid in blood or urine may be used, but is not considered by members of our group to have current credibility in appraising formaldehyde exposures for individuals: one group finding was suggestive.

3) At present, we suspect there are a number of "normal ranges" by individual laboratories for formic acid, but no national consensus has been reached about interpretations.

4) Only after considerably more information re: history and signs and symptoms – and epidemiology of local situation can this case begin to be interpreted.

5) At present, neither urine nor blood phenol is considered a clinically valuable measure of benzene exposure – except in group acute exposures where several reports have found it suggestive.

6) We're not conversant with any recognized reference range because of the many variables contributing to phenol levels.

7) As noted in #6, any one of a number of precursors can lead to "elevated" phenols in urine.

8) As we discussed it, the list of potential contributors is far from complete.

9) A number of ranges have been reported as normals for inorganic arsenic in both adults and children. We've seen differences between 5 and 30 cited as upper limits. In the instance of 40, assuming a repeat sample was confirmatory, one would investigate epidemiologically what was going on.

10) Again, depending upon the laboratory and its competencies – and its track record of being "reasonable", we'd be interested in the clam, oyster, and mussel intake of the individual, because of the organic arsenic – and some changes that happen within the body with reference to them.

11) At present, we're still wrestling with two environmental exposures of some 30 years' duration here in the state of Washington and have no consensus about levels – because of the acute nature involved, as opposed to lead -where even that is still debatable. And – as with lead -while chelation can increase urinary excretion, for lower levels of both, we're oblivious of any control studies of meaningful effectiveness completed here in the States.

Regarding the immunologic issues, in one of our suburbs, virtually 90% of the children are "allergic" as a cause of their recurrent sinus infections – according to the Internet. As of the moment, our local groups consider Interluekin testing preliminary and serologic levels for numbers 3, 4, 5, and 6, also in the preliminary stage.

If one be a devotee for the "precautionary principle" – it might or it may or it could make one sick – a bountiful field of economic profit awaits him or her!

As an individual, I must reveal an existing bias of skepticism towards the current rage of "environmental illness". Hope this proves helpful.

Sincerely,

William O. Robertson, MD
Medical Director, Washington Poison Center
Professor of Pediatrics, UW School of Medicine

WOR/tal

DEPARTMENT OF HEALTH & HUMAN SERVICES

Public Health Service

Agency for Toxic Substances
and Disease Registry
Atlanta GA 30333

August 5, 1999

Dr. Rick Kreutzer, MD
Environmental Health Investigations Branch
California Department of Health Services
1515 Clay Street, Suite 1700
Oakland, CA 94612

Dear Dr. Kreutzer

The Agency for Toxic Substances and Disease Registry (ATSDR) appreciates the opportunity to provide assistance to the California Department of Health Services in regard to the evaluation of possible environmental exposure from portable classrooms in southern California. Enclosed, please find ATSDR's evaluation of the specific questions provided by the California Department of Health Services, as requested during our telephone conversation on July 28, 1999. If you have any additional questions or concerns, please feel free to contact Joseph Little at (404) 639-6360 or Hana Pohl at (404) 639-6308.

Sincerely yours,

Joseph D. Little, MSPH
Emergency Response Coordinator
Division of Toxicology

Hana R. Pohl, MD, Ph.D.
Medical Officer
Division of Toxicology

Enclosure

ATSDR Response to California Department of Health Questions

1. What is the role of laboratory testing in assessing children with symptoms of recurrent headaches, sinus infections, cough, that parents attribute to possible exposure from portable classroom contaminants?

Laboratory testing should be utilized as an adjunct to a thorough history and physical examination. Development of a differential diagnosis for diseases of other origin (e.g., infectious for cough, tumors for headache, etc.) should be considered. As explained further, there are no reliable biomarkers of exposure for formaldehyde.

2. **Is formic acid in blood or urine a validated biomarker for formaldehyde exposure in children?**

Formic acid in blood or urine is not a validated biomarker for formaldehyde exposure in humans.

A thorough review of the available literature failed to produce any reliable biomarker of exposure to formaldehyde. Formaldehyde is a simple one-carbon molecule and is rapidly absorbed and metabolized with a plasma half-life of approximately 1.5 minutes. Formaldehyde is primarily metabolized to formate and C02. Studies in humans and animals exposed to low ppm levels of formaldehyde in air have not shown significant differences between pre- and post-exposure blood concentrations of formaldehyde (Heck et al. 1985). Based on the available data, it appears that the detection of the intact formaldehyde molecule in the blood and tissues is an unreliable and poor indicator of formaldehyde exposure in humans and laboratory animals.

Formic acid (fortnate) levels are also not reliable for assessing formaldehyde exposure or adsorption. Urinary formic acid levels were shown to be subject to a 30-fold inter- and intra-individual variation and did not correlate with known exposures to formaldehyde. Formic acid is not a suitable biomarker for formaldehyde exposure (Schmid et al. 1994). Development of biomarkers for exposure is further complicated by the fact that the metabolism of many xenobiotics can result in formaldehyde production. Carbon tetrachloride, endrin, paraquat, 2,3,7,8-tetrachlorodibenzo-p-dioxin, and dichloromethane are all known to generate formaldehyde during their metabolism (Dekant and Vamvakas 1993). The presence of a small amount of endogenous for-mate in human urine is normal, however, fox-mate derived from the metabolism of formaldehyde, several other industrial compounds (methanol, halomethanes, acetone) and some pharmaceutical compounds (methenamine, N-methyltriazine, hexamethyl-melanine, -isopropyl-methoxamine, ephedrine and methylephedrine) may elevate the urine formate concentration above normally expected values. Given the poor understanding of the normal variation of for-mate concentration in the urine, its use as a biological indicator of chemical exposure becomes questionable (Micromedex, Meditext, Formaldehyde, 1999)

Immunological biomarkers (IgG and IgE) have also been explored Antibodies to the formaldehyde antigen have been found to be elevated in a small percentage of people exposed to formaldehyde (Patterson et al. 1986; Thrasher et al. 1988,1989,1990). In many cases, a relationship between formaldehyde exposure and the presence of antibodies was difficult to establish, and when established, the antibodies produced tended to be nonspecific to formaldehyde (Dykewicz et al. 1991; Grammar et al. 1990).

3. **Is there an established "normal range" for blood or urine formic acid levels in children?**

There is no established normal range for blood or urine formic acid levels in humans.

4. **How would you approach the assessment of a child reported to have a level of formic acid in urine of 91.3 mg/L (66.2 mg/g creatinine, lab reference range 21-26mg/L)?**

The first action to be taken should be to verify the results of the tests and to consider comparing results to a control population sampled from the same school. Depending on the number of children sampled originally, individual variability may be accounting for elevated levels. Laboratory results need to be compared to an appropriate control group, as well as correlated with clinical signs and symptoms.

Formic acid or formate is produced from formaldehyde arising from both exogenous and endogenous sources and can be measured as reported by Baumann and Angerer (1979). However, it is a poor biomarker of exposure. The measurement of formaldehyde conjugates of IgE and IgG in people exposed to formaldehyde has been shown (Thrasher et al. 1989) but has not resulted in a routine method, because of the poor correlation to exposure levels. Because the biomarkers of exposure to formaldehyde are not well developed, biomarkers of effects must be utilized.

5. Is blood or urine phenol a validated biomarker for benzene exposure in children?

There is no reliable biomarker for chronic low level exposure to benzene in children.

Phenol in urine may be a questionable biomarker for low level benzene exposure in children. Measurement of benzene in blood and breath is generally not clinically useful in nonoccupational settings. Urinary phenol concentrations do not correlate with airborne benzene levels below 10 ppm (ATSDR, Case Studies In Environmental Medicine, Benzene Toxicity, 1992).

Measurement of benzene in breath and blood can be useful in certain occupational settings. Because of benzene's relatively short biologic half-life, blood levels do not reflect cumulative body burden. A less invasive measurement of exposure in the workplace may be the benzene

concentration in end-expired air. Studies show that 16 hours after an 8-hour exposure to benzene levels of 10 ppm and 1 ppm, steady-state exhaled benzene concentrations are 50 ppb and 10 ppb, respectively. However, these methods are not clinically useful for patients exposed to the low levels of benzene typically found in ambient air. (ATSDR, 1992)

Urinary phenol concentrations generally correlate well with benzene exposure at concentrations above 10 ppm, as can be measured in some occupational settings. Exposure to 10 ppm for 8 hours typically produces a postshift urinary phenol level of 45 to 50 milligrams per liter (mg/L). With exposure to air levels below 10 ppm, high background excretion of phenol from dietary and other sources can render urinary phenol levels unreliable. Unexposed persons rarely have urinary phenol levels greater than 20 mg/L. (ATSDR, 1992)

Urine phenol levels in unexposed individuals are less than 10 mg/L. Urine phenol levels after chronic inhalation exposure to airborne concentrations of 0.5 to 4 ppm are less than 30 mg/L. Urine phenol levels after exposure to 25 ppm average 200 mg/L (Baselt et al. 1989).

In a small group of chemical workers whose TWA exposure to benzene was 0.4 ppm, no correlation was found between the TWA exposure and urinary phenol excretion (Perbellini et al. 1988). Additionally, analysis of data collected from 49 chemical workers in the coke oven industry led the examiners to conclude that urinary phenol could not be used as an indicator of benzene uptake for exposures of about 1 ppm or less (Drummond et al. 1988). Concomitant exposure to other chemicals (e.g., toluene) may have affected the metabolism of benzene.

The data suggest that variations in urinary phenol due to other factors interfere with determination of phenol formed from low levels of benzene. Therefore, benzene exposures of 10 ppm or less would be difficult to monitor by measuring urinary phenol levels, and consequently, correlations between phenol levels and LOAELs would not be likely for effects occurring in this dose range. Additionally, for exposures of less than or equal to 1 ppm, workplace standard, urinary phenol is an inadequate assay to determine extent of benzene exposure. Nevertheless, the measurement of urinary phenol is still useful in determining whether or not an individual has been exposed to substantial levels of benzene, as observed in some occupational settings. In such situations, biological exposure indices (BEI) are directly correlated with threshold limit values. The ACGIH had established 50 mg phenol/g creatinine in the urine as a BE1 for benzene exposure in the workplace (ACGIH 1996). The BE1 is primarily an index of exposure and not a level at which health effects might occur from exposure to benzene. (ATSDR, Toxicological Profile for Benzene, 1997)

Benzene is converted by the liver into water-soluble metabolites which are conjugated and excreted in the urine. Benzene is metabolized extensively in the liver and excreted in the urine, with 51 to 87% excreted as phenol, 6% as catechol, and 2% as hydroquinone (Baselt et al. 1989). Metabolites include: phenol 23 to 50% detected in urine; catechol3 to 5% detected in urine; hydroquinone 1 to 5% detected in urine; phenylmercapturic acid 0.5% detected in urine; benzene dihydrodiol 0.3% detected in urine; trans,trans-muconic acid 1.3% detected in urine;

hydroxyquinone 0.3% detected in urine (NTP 1986). The elimination half-life is reported to be 9 to 24 hours in humans. (Micromedex, Meditext, Benzene, 1999)

Measurement of phenolic derivatives in urine is most frequently used for biological monitoring, but is unsatisfactory for chronic low level benzene exposure. Analysis of urinary t,t-muconic acid appears to be a better indicator than phenol for assessment of exposure to low levels of benzene (Ghittori et al. 1993). Phenylmercapturic concentration in the urine is a highly specific parameter, although data concerning dose response relationship between phenylmercapturic acid production and benzene in workers are not yet available (Ghittori et al. 1993). Urinary levels of mucinic and S-phenylmercapturic acids, sampled at the end of a work shift, were better indicator of exposure to benzene in automobile mechanics than benzene (Popp et al. 1994). The American Conference of Government al Industrial Hygienists (ACGIH) Biological Exposure index (BEI) for benzene is S-Phenylmercapturic acid in urine at 25 mcg/g creatinine. (Micromedex, Meditext, Benzene, 1999)

6. **Is there an established reference range for urine or blood levels for phenol in children?**

There is no established reference range, specifically for children, for urine or blood levels for phenol. Current information concerning biomarkers for phenol are typically applicable to the occupational setting.

Urine Phenol levels in unexposed individuals are generally less than 10 mg/L. Urine phenol levels after chronic exposure to airborne concentrations of 0.5 to 4 ppm are less than 30 mg/L. Urine phenol levels after exposure to 25 ppm average 200 mg/L (Baselt et al. 1989)

With exposure to air levels below 10 ppm, high background excretion of phenol from dietary and other sources can render urinary phenol levels unreliable. Unexposed persons rarely have urinary phenol levels greater than 20 mg/L. Under occupational conditions, urinary phenol concentrations generally correlate well with benzene exposure above 10 ppm. Exposure to 10 ppm for 8 hours typically produces a postshift urinary phenol level of 45 to 50 mg/L (ATSDR, 1992).

Refer to discussion in question #5.

7. **Does a result of 100mcg/ml (lab reference is < 10 mcg/ml) in a child indicate an exposure to excess levels of benzene?**

A result of 100 mcg/ml (100 mg/L) phenol in urine may indicate an exposure to benzene and should trigger further evaluation. It should be noted that there are many other compounds which can also affect urine phenol levels.

8. What other compounds can affect the results of a blood or urine phenol test?

Urinary phenol measurements have routinely been used for monitoring occupational exposure to benzene (OSHA 1987), and there is some evidence that urinary phenol levels can be correlated with exposure level (Astier 1992; Inoue et al. 1986, 1988; Karacic et al. 1987; Pagnotto et al. 1961; Pekari et al. 1992). However, correlating urinary phenol with benzene exposure is complicated by potentially high and variable background levels of phenol that result from ingestion of vegetables, exposure to other aromatic compounds, ingestion of ethanol, and inhalation of cigarette smoke (Nakajima et al. 1987). Relatively high urinary phenol levels (5-42 mg/l) have also been found in persons with no known exposure to benzene (NIOSH 1974). In addition, coexposure to toluene, a common solvent, has been shown to inhibit transformation of benzene to phenol (Inoue et al. 1988). (ATSDR, Toxicological Profile for Benzene, 1997)

Some over the counter medications containing phenol may give false positives and/or increase urine phenols. Examples are Peptobismol and Chloraseptic (Baselt et al. 1989)

9. **What is a "normal range" for urinary inorganic arsenic in children?**

No normal ranges, specifically for children, for urinary inorganic arsenic were located.

Normal total urinary arsenic values, for humans in general, are less than 50 micrograms arsenic per liter (As/L) in the absence of consumption of seafood in the past 48 hours; values in excess of 200 mcg As/L are considered abnormal (ATSDR, Case Studies in Environmental Medicine, Arsenic Toxicity, 1990)

The key diagnostic laboratory test for recent arsenic exposure is urinary arsenic measurement. The best specimen is a 24-hour urine collection, although spot urine specimens can be helpful in an emergency. Test results may be reported in micrograms arsenic per gram creatinine to avoid effects due to variation in urine output (ATSDR, 1990).

Quantitative 24-hour urine collections are the most reliable laboratory measure of arsenic poisoning. A chelated or nonchelated 24 hour urinary arsenic collection exceeding 100 mcg is usually abnormal. Even with chelation an unexposed individual should not rise above 100 mcg per 24-hour total urine output (Micromedex, Meditext, Arsenic, 1999).

Following occupational exposure, the Biological Exposure Index (BEI) for inorganic arsenic metabolite in urine is 50 mcg/g creatinine (ACGIH 1998). A proposed change in the BEI for inorganic arsenic and methylated metabolites in urine is 35 mcg As/L (Micromedex, Meditext, Arsenic, 1999). The BEI is primarily an index of exposure and not a level at which health effects might occur.

Most arsenic that is absorbed from the lungs or the gastrointestinal tract is excreted in the urine,

mainly within l-2 days. For this reason, measurement of urinary arsenic levels is generally accepted as the most reliable indicator of recent arsenic exposure (Milham & Strong 1974; Polisa et al. 1990).

An important limitation to the use of total urinary arsenic as a biomarker of exposure is that arsenobetaine is excreted (unmetabolized) in urine after ingestion of certain seafoods (Brown et al. 1990; Kalman 1987; Tom et al. 1982). Since "fish arsenic" is essentially nontoxic, analytical methods based on total urinary arsenic content may overestimate exposures to arsenic species that are of health concern. Urinary arsenic may be elevated up to 200 to 1700 mcg/L within 4 hours after eating some seafoods (Baselt & Cravey, 1989). Fish arsenic can significantly increase total urinary arsenic levels, therefore, it may be prudent to take a dietary history of the previous 48 hours or repeat the urinary arsenic test in 2 or 3 days. Human volunteers with an average pretest urinary arsenic level of 30 mcg/L were given lobster tail for lunch. Four hours after eating, they had an average urinary level of 1300 mcg As/L. These values decreased to pretest levels within 48 hours after ingestion. Arsenic blood levels, normally less than 7 mcg/dL are less useful than urinary arsenic measurements in following the clinical course of an acute poisoning case because of the rapid clearance of arsenic from the blood. (ATSDR, Case Studies in Environmental Medicine, Arsenic Toxicity, 1990)

Arsenic levels in blood, urine, hair, and nails have been investigated and used as biological indicators of exposure to arsenic. Since arsenic is cleared from blood within a few hours (Tam'et al. 1979; Vahter 1983), measurements of blood arsenic reflect exposures only within the very recent past. Typical values in nonexposed individuals are less than 1 mcg/L (Heydom 1970; Hindmarsh & McCurdy 1986; Valentine et al. 1979). Consumption of medicines containing arsenic'is associated with blood values of 100-250 mcg/L, while blood levels in acutely toxic and fatal causes may be 1,000 mcg/L or higher (Driesback 1980). However, blood levels do not appear to be reliable indicators of chronic exposure to low levels of arsenic (Valentine et al. 1979, 1981). A blood level of arsenic below 7mcg/100 mL is considered in the normal range. Blood levels are highly variable and may be useful only after acute exposure to confirm diagnosis (Fesmire et al. 1988).

Long after urine levels have returned to baseline, the arsenic content of hair and nails may be the only clue of arsenic exposure. However, because the arsenic content of hair and nails may be increased by external contamination, caution must be exercised in using the arsenic content of these specimens to diagnose arsenic intoxication. (ATSDR, Case Studies in Environmental Medicine, Arsenic Toxicity, 1990)

Arsenic tends to accumulate in hair and nails, and measurement of arsenic levels in these tissues may be a useful indicator of past exposures. Normal levels in hair and nails are 1 ppm or less (Choucair & Ajax 1988; Franzblau & Lilis 1989). These values may increase from several-fold to over 100-fold following arsenic exposure (Agahian et al. 1990; Bencko et al. 1986; de Peyster & Silvers 1995; Karagas et al. 1996; Landau et al. 1977; Milham & Strong 1974; Southwick et al. 1981; Valentine et al. 1979; Yamauchi et al. 1989) and remain elevated for 6-12 months

(Choucair & Ajax 1988).

Analysis of hair may yield misleading results due to the presence of arsenic absorbed to the external surface, but this can be minimized by collecting samples from close to the scalp or from unexposed areas and by washing the hair before analysis (Paschal et a1.1989).

10. Would you be concerned by a result of 40 mcg/g (52 ng/ml) for inorganic arsenic in urine?

A result of 40 mcg/g creatinine and 52 ng/ml for inorganic arsenic in urine are not at levels that would be considered a health concern.

Normal total urinary arsenic values are less than 50 mcg/L (50 ng/ml) in the absence of consumption of seafood in the past 48 hours; values in excess of 200 mcg/L (200ng/ml) are considered abnormal (ATSDR, 1990). A value of 52 ng/ml would not be considered significantly different than 50 ng/ml.

The Biological Exposure Index (BEI), following occupational exposure, for inorganic arsenic metabolite in urine is 50 mcg/g creatinine (ACGIH, 1998). The BE1 is primarily an index of exposure and not a level at which health effects might occur.

11. What level of arsenic in urine would you consider potentially toxic? At what level would you recommend chelation therapy?

Chelation therapy, in general, is recommended **only** for patients who are symptomatic in addition to evidence of poisoning confirmed by specific laboratory analysis of biological samples. All known chelating agents have adverse side effects and should be used with caution. In animal models, the efficacy of chelation therapy generally declines as the time elapsed, since exposure, increases. If patients are treated within several hours after ingestion, chelation is likely to be beneficial. Gut decontamination and hemodynamic stabilization are key factors in the initial management of acute arsenic intoxication. Chelating agents administered within hours of arsenic absorption may successfully prevent the full effects of arsenic toxicity. Dimercaprol (2,3-dimercaptopropanol, also known as British anti-Lewisite or BAL) is the most frequently recommended chelating agent for acute arsenic poisoning. (ATSDR, Case Studies in Environmental Medicine, Arsenic Toxicity, 1990)

Immunology questions

1. What is the role of an immunologic evaluation in assessing a child with recurrent upper respiratory or sinus infections?

Evaluation of the immunologic status and possible deficiencies, including serum immunoglobulin studies may prove useful in the evaluation of a child with recurrent upper respiratory infection. Assays for causes of immunocompromise might be considered (HIV, malignancy).

2. **What is the usefulness of Interleukin-2 production test results in children? What is a "normal range" for interleukin-2 production in children? (the lab reference range is "3-5 U/million lymphocytes")**

Interleukin-2 is a mitotic lymphokine produced by T cells that stimulates growth of activated T cells. Interleukin-2 also appears to augment NK-cell cytolytic function, producing so-called lymphokine activated killer (LAK) cells; it also acts on human B cells both as growth factor and as a stimulator for antibody synthesis. The quantity of interleukin-2 synthesized by activated T cells is an important determinant of the magnitude of immune responses. Because of its growth stimulation of activated T cells, interleukin -2 plays a role as a mediator of delayed hypersensitivity (cell-mediated immunity). Delayed hypersensitivity reactions provide resistance, among others, to fungal infections. Centers for Disease Control and Prevention (CDC) should be contacted for specific questions concerning Interleukin-2 levels.

3. Do increased serologic levels of IgE, IgG, or IgA to stachybotrys chartarum indicate high environmental exposure?

See #6.

4. **Does increased stachybotrys chartarum IgA level accurately indicate recent exposure to stachybotrys chat-tat-urn?**

See #6

5. Does increased stachybotrys chartarum IgG level accurately indicate past exposure to stachybotrys chartarum?

See #6

6. Does increased Stachybotrys chartarum IgE level accurately indicate allergic reaction to stachybotrys chartarum?

Answers to questions 3., 4., 5., and 6: The questions deal with the biology of the immune

response. In general, secretory IgA protects the mucous membranes in the respiratory and gastrointestinal tracts as the first line of defense against invasion by microorganisms. IgG is a major immunoglobulin in normal serum and occurs mainly in secondary immune responses. IgE antibody is associated with such immediate hypersensitivity reactions as anaphylaxis and atopy, but also with immunity to certain helminthic parasites.

However, serologic tests are useful only for systemic fungi (Sherris Medical Microbiology 1994). "Serum antibodies directed against a variety of fungal antigens can be detected in patients infected with those agents. Except for some of the systemic pathogens, the sensitivity, specificity, or both, of these tests have not been sufficient to recommend them for use in diagnosis or therapeutic monitoring of fungal infections." Centers for Disease Control and Prevention (CDC) should be contacted for specific question about Stachybotrys chartarum.

P & K Microbiology Services, Inc. **Tel: 856-427-4044**
The Environmental Microbiology Specialists **Fax: 856-427-0232**
1950 Old Cuthbert Road Unit L, Cherry Hill, New Jersey 08034

July 29, 1999

Dr. Sandy McNeel, DVM
California Department of Health Services
1515 Clay Street, Suite 1700
Oakland, California 946 12

Dear Dr. McNeel:

This letter is to address the five questions outlined in your letter dated July 28, 1999.

1. In your opinion what is a reasoned approach to determining the presence of S.c. *(Stachybotrys chartarum) in* a portable school building with no obvious mold or moldy odor?

   I assume that the presence of S.c. means growth of S.c. in contrast to the presence of S.c. spores. A moisture meter should be used to ensure that there is no hidden moisture or water damage. *Stachybotrys chartarum* which is a moisture-loving fungus (Aw >0.95), does not grow well without water. Focus **on** paper products, such as drywall, wallpaper, or cellulose-containing ceiling tiles. S.c. does not grow well on wood products because of the presence of lignin. S.c. is an undesirable fungus in the indoor environment and the only way to verify its presence is to physically locate and identify its growth indoors.

2. If culturable techniques are used, what culture medium is optimal for isolation of S.c. from air, wipe or **bulk samples?**

   S.c. in pure culture can grow on many common fungal media. Its growth, however, may be interfered by the presence of fast-growing fungi, such as *Aspergillus* and *Penicillium.* Jong and Davis (1976) of American Type Culture Collection used cornmeal agar to study and describe species of *Stachybotrys* and *Memnoniella In* a recent study, Tsai et al. (1999a) showed that S.c. grew on all five fungal media (1% malt extract agar, 2% malt extract agar, cornmeal agar, Czapek cellulose agar, and rose begal agar) used in the study. Recovery rate and frequency of S.c. from environmental samples were the highest on cornmeal agar, although the differences were not statistically significant

3. Assuming appropriate culture media what is the range of incubation time needed to culture S.c. on a primary plate? If subculture is necessary?

   Our experience indicates that S.c. is detectable in five to seven days on various media. Jong and Davis (1976) used commeal agar and described "Conidial production in abundance 3 days following inoculation on the plates." In general, S.c. can be easily identified from a primary plate without subculturing by an experienced mycologist

4. How accurate are tape lift samples and non-viable air sampling as methods to determine the presence or absence of S.c.?

   Tape lift sampling is used for the removal of visible and suspect "fungal growth" from surfaces for microscopic examination and fimgal identification. If both spores and conidiophores (conidiophore: a spores- or conidia-bearing structure) are detected, S.c. can be accurately identified. Tape lift sampling of dust is not accurate for the detection of S.c. or its spores because the microscope has small viewing areas at high magnifications (400X or higher). Non-viable air sampling may identify *Stachybotrys-like* spores if only spores are observed. If spores and conidiophores of S.c. appear together in a non-viable

sample, S.c. may be accurately identified In a recent publication, Tsai et al. (1999b) found that non-viable air sampling using Air-O-Cell cassettes had better detection of Stachybotrys-like spores than the detection of *Stachybotrys chartarum on 2%*

Sincerely,

References:

1.

2.

3.